Multinational supermarket chains in developing countries: Does local agriculture benefit?*

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Abstract

There is no consensus in the empirical literature on how entry of multinational supermarket chains affects farmers in developing countries. Econometric analyses struggle with causality issues and are unclear about the channel of effects. We quantify the dynamic effects of supermarket expansion on agriculture within a structural framework that clarifies the adjustment mechanisms involved. The model specification allows for endogenous interaction between agricultural productivity and supermarkets' choice of suppliers. Based on numerical simulations, two results emerge. First, we offer a possible interpretation of the conflicting evidence in the empirical literature. Whether farmers benefit from supermarkets or get stuck in a low productivity trap depends on the extent of local constraints related to production capacity and market access. Second, supply chain development initiated by supermarkets can help farmers escape the low productivity trap. While supermarkets face a short run cost to supplier upgrading, they gradually gain from more productive local suppliers.

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1. Introduction

As part of the globalization process, the past decades have seen a rapid rise of multinational supermarket chains in the developing part of the world (Reardon et al., 2003). The consequences for the agricultural sector are discussed in the literature, but with no conclusive answer. A special issue of *Development Policy Review* focuses on the implications of a rising supermarket sector in Latin America. The key findings are summarized in the overview article by Reardon and Berdegue (2002). The evidence is mixed, and suggests that supermarkets represent both challenges and opportunities for local farmers. Empirical analyses find that farmers supplying supermarkets are relatively more productive, but many farmers are excluded from the supermarket supply chain due to capacity constraints in production and marketing (Hernandez et al., 2007, Neven et al., 2006). However, the econometric approach is unclear about the channel of effects and struggles with causality issues. Does the productivity of farmers increase because they deliver goods to supermarkets, or do supermarkets select the most productive suppliers? We offer a structural framework that clarifies the underlying adjustment mechanisms involved, and allows for endogenous interaction between agricultural productivity and supermarkets' choice of suppliers. Based on numerical simulations we quantify the dynamic effects of supermarket expansion on agricultural productivity, structural change within agriculture, as well as supermarkets' dependence on domestic versus foreign farmers as suppliers.

The model specification assumes an archetype developing economy with duality in both agriculture and the food retail sector. We use the term supermarkets to describe a modern food retail sector that includes large discount stores, supermarkets and hypermarkets, while the traditional food retail sector consists of small shops and public markets. Traditional farmers supply the traditional food retail sector. Commercial farmers deliver goods to both traditional retail and supermarkets, and face competition from foreign farmers. The supermarkets' choice between domestic and foreign suppliers is endogenously determined, and depends on relative productivity and relative prices. Global or regional supermarket chains represent foreign direct investment, and may

generate backward productivity spillovers to the domestic economy. We endogenize the productivity linkage between supermarkets and local suppliers. Productivity growth in commercial agriculture is related to 1) the gap with the agricultural technology frontier, 2) the farmers' degree of interaction with supermarkets as suppliers, and 3) the commercial agriculture sector's level of human capital. The two-way relationship between agricultural productivity and supermarkets' dependence on local farmers is an important aspect of the model specification, and is crucial to capture the dynamic effects of supermarket expansion.

Numerical simulations of the intertemporal general equilibrium model show how entry of multinational supermarket chains affects the agricultural sector under three alternative scenarios. The parameters of the model are set to reproduce the observed and projected supermarket expansion in developing countries during 1990-2015. The first scenario acts as the reference path in the simulation analysis, and represents an economy with a relatively well-developed agricultural sector. The second scenario focuses on the importance of local constraints for the impact of supermarkets on agriculture. Local constraints typically related to production capacity (credit access, level of education/skills, irrigation etc.) and market access (infrastructure, electricity, communication facilities etc.) are captured in the model simulations via the aggregate rural skill share, which can be seen as a broad measure of the agricultural level of development, and thereby the extent of domestic constraints facing local farmers.[1] Our incorporation of the productivity linkage between supermarkets and local farmers offers a possible interpretation of the conflicting results in the empirical literature: depending on the degree of local constraints, farmers either benefit from supermarkets through

[1] The model specification separates between rural and urban labor, where the first is employed in traditional and commercial agriculture. The rural labor force is further divided into skilled and unskilled workers. The aggregate rural skill share is the share of skilled workers in the rural labor force and is exogenous (as we do not model the supply of skilled workers endogenously). Rural skilled labor is employed in commercial agriculture only, which implies that the skill share in traditional agriculture is per definition equal to zero. Since rural unskilled labor is allocated between the agricultural sectors based on marginal productivities, the share of skilled workers in the labor force of commercial agriculture develops endogenously. The model thus separates between the exogenous aggregate rural skill share (which is our broad measure of the extent of constraints facing local farmers) and the endogenous skill share in commercial agriculture (which enters the productivity specification outlined in section 2).

productivity spillovers and increased demand, or they get stuck in a low productivity trap with limited interaction with the supermarket sector.

In the third scenario, we consider the effect of agricultural skill upgrading initiated by supermarkets. Supply chain development may include sub-contracting, training, credit access and improvement of organizational structure, among other factors. Our simulation shows that supply chain development improves the ability of farmers to take advantage of productivity spillovers, and can help farmers escape the low productivity trap. Supermarkets face a short run cost to supplier upgrading, but gradually gain from more productive local suppliers. Compared to the scenario without agricultural skill upgrading, supermarkets over time obtain a larger market share and become more reliant on local farmers. Our result suggests that when farmers do not meet the required standards, supermarkets have an incentive to invest in farm assistance programs that improve the productivity of local suppliers. In light of the present analysis, entry of supermarket chains in developing countries represents an important contribution to agricultural productivity improvement, either directly, through backward productivity spillovers, or indirectly, through farm assistance programs.

Supermarket expansion not only affects farmers in the supply chain, but also has consequences for the rest of the food retail sector. Traditional retailers face increased competition and potential loss of market share, but may benefit from foreign supermarkets through spillover effects of the latest retail techniques. Large supermarket chains are also likely to affect the average retail prices in the markets they enter. These issues are studied by Basker (2005, 2007) for the case of Wal-Mart, but are beyond the scope of the present paper.

The rest of the paper is organized as follows. Section 2 presents the modeling of the potential productivity linkage between supermarkets and local farmers, while the main elements of the intertemporal general equilibrium model are given in section 3. The impact of an expanding supermarket sector, and in particular the effect of local constraints, is analyzed in sections 4 and 5. Section 6 investigates the consequences of

supply chain development initiated by supermarkets for both local farmers and the supermarket sector. Section 7 offers concluding remarks.

2. The productivity linkage between supermarkets and local suppliers

As mentioned in the introduction and further documented below, empirical analyses find that farmers in the supermarket supply chain are more productive than traditional farmers. Of course, the direction of causality is an issue of debate. Delivering goods to supermarkets may increase the productivity of farmers through backward linkages, but at the same time supermarkets are likely to select the most productive suppliers. We offer a model specification that takes both directions into account and captures the endogenous interaction between supermarkets' choice of suppliers and agricultural productivity. Numerical simulations show how the two-way relationship between supermarkets and local farmers acts to reinforce dynamic processes (either decreasing the chances of escaping a low productivity trap or strengthening technological catch-up), and is important to capture the dynamic effects of the supermarket expansion. In this section we present the modeling of the potential productivity gain facing local farmers supplying supermarkets, while the full general equilibrium model is given in the next section.

Productivity improvements in developing countries, both economy-wide and in the agricultural sector, are typically driven by learning from abroad and technology transfer rather than own innovation activities. There is a broad empirical and theoretical literature relating the adoption of foreign technology to the technological distance to the world frontier. The technology gap formulation was first introduced by Nelson and Phelps (1966), and later modified by Benhabib and Spiegel (2005). In an analysis of the agricultural sector in Mediterranean countries, Hassine (2008) documents a positive and significant effect of the technological distance to the agricultural frontier on productivity growth. The larger the technology gap, the larger is the learning potential, and thus the higher is the productivity growth rate.

Findlay (1978) emphasizes the importance of technological contagion to benefit from the technology gap, and relates technology transfer to the degree of foreign direct investment in the domestic economy. Supermarkets in developing countries are mainly global chains, and in this respect their entry represents foreign direct investment and acts as a transmission channel of foreign technology.[2] There is a growing empirical literature indicating that supermarkets impose a positive productivity effect on farmers in their supply chain. Based on field interviews with supermarkets and a farm survey among tomato growers in Guatemala, Hernandez et al. (2007) find that farmers supplying supermarkets both had more irrigation initially and also invested more in irrigation over time than farmers in the traditional channel. This has further implications for productivity. Neven et al. (2006) find similar results in an analysis of the Kenyan supermarket sector. Labor productivity is about 70% higher among supermarket-channel farmers than among farmers that supply traditional retail. These analyses struggle with identification of causal effects, which motivates our type of simulation analyses that captures the endogenous interaction between supermarkets and the productivity of suppliers.

A large literature of open economy growth has shown theoretically and empirically how human capital affects productivity growth. The early contribution of Nelson and Phelps (1966) emphasizes the role of human capital in technology adoption. The ability to take advantage of foreign technology increases with the human capital level of the labor force. Based on cross-country analyses, Benhabib and Spiegel (1994) and Vandenbussche et al. (2006) document the positive effect of education on economy-wide productivity growth. Hassine (2008) focuses on the agricultural sector and finds strong evidence that the level of education affects agricultural productivity growth by increasing the capacity to adopt foreign technologies. Alene and Manyong (2007) separate between traditional and modern agriculture in northern Nigeria, and show that schooling has a productivity-enhancing effect in the modern sector. Based on household-level data from rural India,

[2] According to data on Latin American countries the average share of multinationals in the supermarket sector is 56%, and about 60-80% of the top five supermarket chains are global multinationals (Reardon and Berdegue, 2002).

Foster and Rosenzweig (1995) document the importance of experience and learning by doing for agricultural productivity.

Consistent with the theoretical and empirical literature discussed above, we relate productivity growth in commercial agriculture to 1) the technology gap with the world agricultural frontier, 2) the farmers' degree of interaction with supermarkets as suppliers, and 3) the commercial agriculture sector's level of human capital. In our model specification, domestic commercial farmers compete with foreign farmers in delivering goods to the supermarket sector. We model backward productivity spillovers via the supermarkets' share of supply from domestic farmers.[3] The more dependent the supermarkets are on local suppliers, the stronger is the productivity linkage.[4] Human capital is measured by the share of skilled workers in commercial agriculture.[5] The skill level can be related to both formal education and work experience. By using the skill share in commercial agriculture (rather than the aggregate rural skill share) we take into account that inflows of poorly educated workers from traditional agriculture weaken the commercial agriculture sector's ability to benefit from foreign technology spillovers.

We specify the rate of labor augmenting technical progress in commercial agriculture in period t ($\hat{A}_{c,t}$) as follows:

$$\hat{A}_{c,t} = \lambda H_t^{\theta_1} \left(\frac{ND_t}{N_t} \right)^{\theta_2} \left(1 - \frac{A_{c,t}}{A_t^*} \right) \tag{1}$$

where $A_{c,t}$ and A_t^* represent the productivity levels of commercial agriculture and the agricultural technology frontier, respectively, $\frac{A_{c,t}}{A_t^*}$ is relative productivity, and H_t is the

[3] The linkage between supermarkets and domestic suppliers does not enter the productivity relation with a scale effect. Consistent with the long-run steady state properties of the model we use the share of supermarket supply from domestic farmers as argument. The long-run value of this variable is constant, which is a necessary condition for balanced growth and constant technology gap in the long run. Scale effects imply an endogenous growth model with different long-run properties. The same logic applies to the use of the skill share, rather than the number of skilled workers to measure human capital.

[4] A related specification with productivity spillovers from the export sector to its intermediate suppliers is applied by Diao et al. (2006) for the case of Thailand.

[5] The skill share in commercial agriculture is defined as $Ls_t/(Lu_{c,t} + Ls_t)$, where Ls_t and $Lu_{c,t}$ are skilled and unskilled rural labor employed in commercial agriculture.

commercial agriculture sector's level of human capital. The productivity linkage between commercial farmers and supermarkets is related to supermarkets' dependence on local farmers as suppliers. ND_t is deliveries from domestic commercial farmers to supermarkets, while N_t is total demand for agricultural goods by the supermarket sector. The parameters λ, θ_1 and θ_2 are constant.

The productivity dynamics are illustrated in Figure 1. The horizontal axis shows the relative position to the world agricultural frontier, while the productivity growth rate is given on the vertical axis. The further to the left the economy is positioned, the larger is the technology gap. Productivity growth at the agricultural frontier is set exogenously. When the productivity growth rate in commercial agriculture exceeds the growth rate of the frontier, the sector is catching up and the gap decreases. Equivalent, lower productivity growth than the frontier increases the gap, as illustrated with arrows in the figure.

Figure 1 about here.

The productivity dynamics may generate both technological catch-up and divergence (illustrated by curve *i* and *ii*, respectively). The extent of productivity spillovers is determined by the supermarkets' dependence on domestic farmers as suppliers, while the ability to take advantage of these spillovers is related to the level of human capital. With sufficient level of absorptive capacity, the productivity dynamics are consistent with technological convergence. Long-run productivity growth is given by the exogenous growth rate of the world agricultural frontier, and the technology gap is constant (marked as $(A_c/A^*)^E$ in Figure 1). The degree of catch-up depends on the human capital level and the farmers' linkage to the supermarket sector. Low level of absorptive capacity, represented by lack of interaction with supermarkets and/or low human capital level, may generate technological divergence with increasing technology gap over time. Since the share of skilled workers in commercial agriculture and the farmers' degree of interaction with supermarkets are endogenous, switching between the two development paths is possible.

The suggested productivity specification is in line with recent contributions in the empirical and theoretical literature on agricultural productivity growth and technology diffusion. But the ability to absorb and take advantage of foreign technology is complex and affected by multiple factors. We offer a reduced form specification, where the human capital level and farmers' degree of interaction with supermarkets represent the absorptive capacity of the sector. Factors heterogeneous at the farm level (geographical location, initial wealth, farm size, and degree of risk/uncertainty, among others) are not accounted for in the present model specification. Future interaction of theoretical and empirical research can strengthen this analysis in terms of how to best capture the true productivity relationship.

3. A Ramsey model of an agricultural oriented economy[6]

To study the impact of an expanding supermarket sector on local agriculture the productivity dynamics are placed in an intertemporal general equilibrium setting. The main advantage of this methodology is to separate between short-run and long-run effects, and to clarify the adjustment mechanisms involved. Existing Ramsey analyses with focus on agricultural issues typically model the interaction between a traditional agricultural sector and a modern industrial sector (see for instance Love, 1997; Stifel and Thorbecke, 2003). General equilibrium modeling of supermarkets and local agriculture is scarce, and the recent contribution by Roe and Diao (2004) is one of few analyses. In a Ramsey growth framework they show that the supermarket expansion can be understood as a natural process of economy-wide economic growth. The results are driven by differences in capital intensity between supermarkets and the traditional food retail sector. The analysis includes a vertical linkage between the retail sectors and agriculture in the sense that commercial farmers deliver goods to supermarkets, while traditional farmers supply the traditional retail sector. But the analysis does not consider the potential productivity linkage between supermarkets and the agricultural sector, which is

[6] This section presents the main equations of the model, while the full model documentation is given in a separate appendix available from the author.

the main focus of the present paper. The importance of agricultural productivity for overall economic growth is illustrated by Irz and Roe (2005), while Diao et al. (2005) discuss the interplay between productivity and capital accumulation.

The model represents an archetype developing economy with duality in both agriculture and the food retail sector. The economy is disaggregated into five sectors: Traditional and commercial agriculture, traditional and modern food retail sectors, and the rest of the economy. We use the term supermarkets to describe the modern food retail sector, which includes large discount stores, supermarkets and hypermarkets. The traditional food retail sector represents small shops and public markets. The retail sectors and traditional agriculture are non-traded, and the price levels are determined endogenously at the domestic market. The rest of economy good and the commercial agricultural good are imported, and the modeling assumes imperfect substitution between domestic and foreign goods through an Armington composite system. To simplify the analysis agricultural exports are ignored. All exports are done by the rest of economy sector, where we assume imperfect substitution between sales to domestic markets and export markets.

The labor force consists of rural and urban labor, where the first is employed in the agricultural sectors and the second in the three other sectors. Since the main focus of the analysis is on agriculture the rural labor force is further divided into skilled and unskilled workers. The intention is to capture the fact that commercial agriculture is relatively more skill intensive and that skilled workers are more important for productivity growth. While skilled rural labor is only employed in commercial agriculture, unskilled rural labor is perfectly mobile and is allocated between the two agricultural sectors based on marginal productivities. When commercial agriculture is expanding, unskilled farmers gradually leave traditional agriculture and migrate to the commercial part. However, the model specification does not consider the possibility of rural-urban migration, which is likely to depend on the conditions in the commercial sector. With commercial agriculture stuck in a low productivity trap, unskilled farmers may choose to migrate to urban areas instead. The supply of all labor types (including rural skilled workers) is assumed to grow exogenously at the long run rate. However, entry of multinational supermarket chains and

gradual modernization of the agricultural sector may encourage workers to upgrade their skill level. In the simulation analysis, we study the implications of an exogenously imposed upgrade of the agricultural skill level. But these issues should be further investigated in future analyses, and both rural-urban migration and endogenous skill creation represent natural extensions of the present model.

Traditional and commercial agriculture differ with respect to skill level, extent of foreign competition and potential markets. Traditional farmers supply the traditional food retail sector. Commercial farmers deliver goods to both traditional retail and supermarkets, and face competition from foreign farmers. The specification is consistent with farm surveys in Guatemala showing that one group of farmers supply only traditional retail, while another group of farmers supply both traditional retail and supermarkets (Hernandez et al., 2007). The supermarkets' choice between domestic commercial farmers and foreign suppliers is endogenously determined, and depends on relative productivity and relative prices. The model specification captures the endogenous dynamic interaction between supermarkets' choice of suppliers and agricultural productivity. The productivity of commercial farmers increases with their interaction with supermarkets [as described by equation (1) in section 2], and at the same time, more productive local farmers increase the supermarkets' dependence on local suppliers.

Value added in traditional and commercial agriculture ($X_{i,t}$) is specified as follows:

$$X_{a,t} = A_{a,t}^{\alpha_1} AD_{a,t}^{\alpha_2} Lu_{a,t}^{\alpha_1} LD_{a,t}^{\alpha_2} K_{a,t}^{\alpha_3} \tag{2}$$

$$X_{c,t} = A_{c,t}^{\beta_1+\beta_2} AD_{c,t}^{\beta_3} Lu_{c,t}^{\beta_1} Ls_t^{\beta_2} LD_{c,t}^{\beta_3} K_{c,t}^{\beta_4} \tag{3}$$

where $Lu_{i,t}$ and Ls_t are unskilled and skilled rural labor, respectively, $LD_{i,t}$ is land, and $K_{i,t}$ is capital ($i = a, c$). The subscripts a and c represent traditional and commercial agriculture, respectively. Given aggregate land supply being constant over time, exogenous land augmenting technical progress ($AD_{i,t}$) is assumed in order to have balanced growth in the long run. As explained in the previous section, labor augmenting technical progress in commercial agriculture ($A_{c,t}$) is endogenized to capture the potential productivity linkage with supermarkets. In all other sectors productivity grows exogenously at the long run rate.

Value added in the food retail sectors and the rest of the economy is specified as Cobb-Douglas functions of urban labor ($L_{j,t}$) and capital ($K_{j,t}$):

$$X_{j,t} = A_{j,t}^{\gamma_j} L_{j,t}^{\gamma_j} K_{j,t}^{1-\gamma_j} \qquad j = m, tr \tag{4}$$

$$X_{s,t} = cst_t A_{s,t}^{\gamma_s} L_{s,t}^{\gamma_s} K_{s,t}^{1-\gamma_s} \tag{5}$$

where the subscripts *m*, *tr* and *s* represent the rest of the economy, traditional retail, and supermarkets, respectively. The production function for supermarkets takes into account the potential costs related to supply chain development. If local farmers do not meet the required standards, supermarkets may contribute to agricultural skill upgrading so that the supply of rural skilled workers temporarily grows at a higher rate than the long-run growth rate (n). We apply a reduced form specification, where the share of supermarket production value remaining after costs to supply chain development are paid (cst_t) depends on the growth of rural skilled workers ($\hat{Ls}_t$) relative to the long run growth rate:

$$cst_t = \left(\frac{n}{\hat{Ls}_t} \right)^{\nu} \tag{6}$$

where ν is a constant parameter. We do not consider the case of skill downgrading, so $cst_t \leq 1$. If supermarkets invest in supply chain development, the value of their production decreases ($cst_t < 1$). The lower cst_t is, the higher are the skill upgrading costs.

The economy faces a perfect capital market with the interest rate exogenously given from the world market. Investments can be financed through foreign borrowing, and the decisions about savings and investment can therefore be separated, although with a long-run restriction on foreign debt. The investment decision is based on intertemporal profit maximization, and we include adjustment costs in investment. The representative household is forward looking and maximizes an intertemporal utility function subject to the intertemporal budget constraint. The utility maximization gives the Euler equation for optimal allocation of consumption over time:

$$\frac{Q_{t+1}}{Q_t} \frac{PQ_{t+1}}{PQ_t} = \left(\frac{1+r}{1+\rho} \right)^{\sigma} \tag{7}$$

Growth in aggregate consumption (Q_t) depends on the world market interest rate (r), the time preference rate (ρ), the constant intertemporal elasticity of substitution (σ), and the price path (PQ_t).

Within-period consumption is modeled through a Stone-Geary demand system with minimum consumption levels for each good. Hence, the household has non-homothetic preferences, and the income elasticity may differ between goods. Aggregate consumption (beyond minimum consumption) for each time period is defined as:

$$Q_t = cs \cdot \prod_j (C_{j,t} - \bar{C}_j)^{\alpha c_j} \qquad j = m, s, tr \tag{8}$$

where $C_{j,t}$ is consumption of each good and $\bar{C}_j$ is the minimum consumption level. The parameters αc_j and cs are constants. In calibrating the model, the minimum consumption level is assumed to be relatively higher for traditional retail goods, which means that the income elasticity is lower here. When income increases, demand gradually shifts towards goods from the supermarket sector and the rest of economy at the cost of traditional retail goods. As illustrated by the numerical simulations, the change in the consumption pattern drives the expansion of the supermarket sector.

With sufficient level of absorptive capacity in commercial agriculture the long-run equilibrium is characterized by balanced growth. The growth rate is exogenously given as the sum of the rate of labor augmenting technical progress and the labor growth rate, while transition growth is endogenous. The capital stock and the foreign debt both grow at the constant rate in the long run. Productivity growth in commercial agriculture is given by the exogenous growth rate of the world agricultural frontier, and the technology gap is constant. The degree of catch up in commercial agriculture depends on the human capital level and the extent of spillovers from the supermarket sector. These dynamics are consistent with the common understanding that differences in income and productivity levels are permanent, while differences in growth rates are transitory (Acemoglu and Ventura, 2002).

4. Simulation analysis: The reference path

Based on the general equilibrium model developed in the previous section we study how local constraints affect the consequences of supermarket expansion for the agricultural sector. The analysis focuses on the implications for productivity growth and degree of catch-up in commercial agriculture, structural change within the agricultural sector, as well as supermarkets' dependence on domestic versus foreign farmers as suppliers. Local constraints typically related to production capacity (credit access, level of education/skills, irrigation etc.) and market access (infrastructure, electricity, communication facilities etc.) are captured in the model simulations via the share of skilled workers in the rural labor force, which can be seen as a broad measure of the agricultural level of development, and thereby the extent of constraints facing local farmers. The aggregate rural skill share is set exogenously, and the analysis offers numerical simulations of multiple scenarios dependent on the degree of local constraints in agriculture. Our starting point is an economy with a relatively well-developed agricultural sector (in a developing country context), represented by for instance South Africa. We set the rural skill share at 30%, which is consistent with the average share of skilled workers in South African primary sectors during 1990-2005 (Quantec Research, 2007). This scenario acts as the reference path in the simulation analysis.

The model is calibrated based on a prototype Social Accounting Matrix (SAM) for a developing economy. Since the SAM represents the long-run equilibrium it reflects an economy with an established supermarket sector. Supermarkets account for 80% of the food retail sector, which is broadly consistent with the current share in many Western European countries. Following data in Roe and Diao (2004), the supermarket sector is assumed to be more capital intensive than the traditional retail sector. The model parameters are consistent with long run equilibrium, where the growth rate is assumed to equal 4% (2% technological progress rate and 2% labor growth[7]). The parameters of the productivity specification in equation (1) are set according to available econometric

[7] The assumption of 2% labor growth is consistent with data on average annual population growth in low income countries during 1990-2007 (World Bank, 2008).

estimates.[8] In the steady state, growth and relative productivity are constant, and the economic structure is stable. To get transition dynamics the initial capital and productivity levels are scaled down. This takes the economy outside the steady state path, and economic growth and structural change are driven by endogenous adjustment back to equilibrium growth. The parameters of the model, as well as the extent of the initial shock, are set to reproduce the observed and projected supermarket expansion in developing countries during 1990-2015.

In Latin America the average supermarket share of total food sales increased from 10-20% in 1990 to 50-60% in 2000 (Reardon and Berdegue, 2002).[9] The expansion of supermarkets in Asia has in general been similar to the Latin American case, but the take-off started 5-7 years later (Reardon et al., 2003). According to Dries et al. (2004) the supermarket share in Central and Eastern Europe grew from about 5% in the mid-1990s to 40-50% in 2003 in 'first-wave' countries (Poland, Hungary, the Czech Republic), to 20-40% in 'second-wave' countries (Croatia, Romania, Bulgaria), and to 10% in 'third-wave' countries (Russia). The rise of supermarkets in Africa is driven by Kenya and South Africa, but is gradually spreading to poorer countries as well. In both Kenya and South Africa, the supermarket sector has grown rapidly since the mid 1990s and accounts for about 20% and 55%, respectively, of food sales in 2003 (Neven and Reardon, 2004, Weatherspoon and Reardon, 2003). Based on an estimated relationship between the share of supermarkets in food retail and its main drivers of change, Traill (2006) offers projections of the spread of supermarkets to 2015. The results suggest that the supermarket expansion will continue, but not at an explosive rate. The projections for Latin American countries as well as 'first-wave' countries in Central and Eastern Europe lie in the range 40-70%.[10]

[8] The calibration of model parameters and the Social Accounting Matrix are documented in a separate appendix available from the author.

[9] Latin American countries are of course at different stages of the supermarket expansion. In Argentina the supermarket share increased from 34% in 1990 to 58% in 1999 (Rodriguez et al., 2002). In Guatemala the share increased from 15% in 1994 to 36% in 2002 (Hernandez et al., 2007).

[10] The projections are based on the expected development of income per capita and the urbanization rate, while the degree of openness is held at the 2002 level. The potential for supermarket expansion is somewhat larger when the economies are assumed to be completely open by 2010, but the projected shares are still below 80%.

In the model simulations the supermarket sector is expanding, and contributes to a structural shift away from traditional food retail. Supermarkets initially account for 24% of total retail production, but increase its market share to 67% during 25 years. This development is broadly consistent with the supermarket expansion seen in many Latin American and Eastern European countries since 1990, and projected to 2015 by Traill (2006). The expansion of supermarkets is driven by both demand and supply factors. The demand side effect follows from non-homothetic preferences. The demand for the traditional retail good is income inelastic, and the share of the traditional good in total consumer spending is gradually declining from 50% to 20%. The consumption share for the good produced by the rest of the economy is roughly constant over time at 40%, while the share going to supermarket goods increases from 10% to 40% during 25 years. At the supply side capital accumulation above steady state rate generates decreasing capital rental rate, while the wage rate is increasing at above steady state rate. Since the supermarket sector is relatively more capital intensive than traditional retail, it benefits from relatively lower unit costs.

Along the reference path the rural skill share is set to 30%, which reflects a relatively developed agricultural sector with limited constraints related to market access and production capacity. In this setting, commercial agriculture takes advantage of the productivity spillovers from the expanding supermarket sector, and reduces the gap with the agricultural technology frontier. As illustrated in Figure 2 below, relative productivity increases from 33% to 47% during 1990-2015. The labor augmenting technical progress rate is initially 4.2%, which is well above the frontier rate of 2%. As the commercial sector catches up relative to the technology frontier, the productivity growth rate gradually decreases due to lower learning potential, consistent with standard technological convergence theory. During 25 years the average labor augmenting technical progress rate equals 3.4%, which corresponds to total factor productivity (TFP) growth of 1.8%.[11]

[11] The average TFP growth rate is calculated based on a labor share of 0.53 in commercial agriculture.

The degree of catch-up in commercial agriculture depends on the sector's absorptive capacity, which is measured by the sectoral skill share and the farmers' degree of interaction with supermarkets, as described by equation (1) in section 2. Supermarkets choose between domestic and foreign farmers as suppliers of agricultural goods. Over time, foreign goods become relatively less expensive, but this is counteracted by the increase in relative productivity of domestic farmers. During the period of study, domestic farmers account for about 70% of the supply to supermarkets. The strong linkage with the supermarket sector stimulates productivity spillovers and strengthens the degree of catch-up.

With a rural skill share of 30% the skill share in commercial agriculture is initially equal to 82%. But while the aggregate skill share is exogenous, the share of skilled workers in the commercial sector varies over time depending on the allocation of unskilled workers within agriculture. Higher productivity growth together with increasing demand from supermarkets generates a structural shift from traditional to commercial agriculture, which implies movements of unskilled labor towards commercial agriculture.[12] Since the supply of skilled labor grows at a constant rate, inflows of unskilled labor lower the skill share in commercial production from 82% to 58% along the transition path. This decreases the sector's ability to take advantage of productivity spillovers, and limits the degree of catch up towards the world agricultural frontier. The falling skill share contributes to decreasing productivity growth rate over time.

5. Supermarket expansion and local constraints

So far we have seen that when the agricultural sector is relatively developed (with a rural skill share of 30%), commercial farmers benefit from an expanding supermarket sector through productivity spillovers and increased demand. To identify the importance of local constraints related to production capacity and market access, we compare the reference path to scenarios with lower aggregate rural skill share. As mentioned, the share of

[12] The commercial sector increases its share of agricultural production from 25% to about 60% along the transition path.

skilled workers in the rural labor force is assumed to reflect the extent of constraints facing local farmers. With lower rural skill share supermarkets initially account for a smaller share of food sales, but the degree of expansion over time is about the same.[13] The consequences for agricultural productivity and structural change are thus comparable across different scenarios.

Figure 2 about here.

Local constraints act as entry costs and prevent commercial farmers from taking advantage of the productivity linkage to the supermarket sector. With an aggregate rural skill share of 3% the commercial sector get stuck in a low productivity trap with technological divergence, as illustrated in Figure 2. The average labor augmenting technical progress rate equals 1.6% (corresponding to TFP growth of 0.85%) and relative productivity falls from 33% to 30% during 25 years. Compared to the reference path, the average annual productivity growth rate has dropped 1.8%-points, and the 2015 productivity level relative to the world agricultural frontier is 17%-points lower. The productivity growth rate is initially higher than the frontier rate, but decreases over time driven by a gradual decline in the sector's absorptive capacity (see Figure 3 in section 6). The share of skilled workers in commercial agriculture is relatively low (15% on average) and falls over time due to inflows of unskilled traditional farmers. The relative price of foreign agricultural goods is decreasing and the technology gap between domestic and foreign farmers widens (technological divergence). Based on this, supermarkets become increasingly dependent on foreign goods. The share of supermarket supply from domestic farmers decreases from about 60% to 35% (see Figure 4 in section 6), and this further weakens the commercial sector's chances of escaping the low productivity trap.

To determine the threshold level of the aggregate rural skill share necessary for local farmers to benefit from the supermarket expansion and catch-up with the world

[13] With a rural skill share of 3%, the supermarket sector increases its share of food production from 10% to 60% during 1990-2015.

agricultural frontier, we examine intermediate scenarios where the share of skilled workers in the rural labor force lies in the range 3-30%. The results are illustrated in Table 1. When the rural skill share exceeds 5%, commercial farmers take advantage of the productivity spillovers and reduce the gap with the agricultural technology frontier. The degree of catch-up increases with the share of skilled workers in agriculture, and to achieve at least 10% points increase in relative productivity during 1990-2015 the rural skill share has to exceed 20%. The quantitative effects obviously depend on parameter assumptions in the model calibration. The robustness of the results is investigated, in particular with respect to elasticities in the productivity specification, and the threshold skill share lies in the range 3-7% within standard parameterization. The reported results reflect the chosen initial shock to the economy. We set the initial technology gap and the initial capital stock to reproduce the observed and projected supermarket expansion during 1990-2015. Alternative calibrations affect both the degree of supermarket expansion and the calculated effects for the agricultural sector.

Table 1 about here.

Table 1 also shows how the commercial skill share and supermarkets' dependence on local farmers vary with the extent of local constraints. The average skill share in commercial agriculture is obviously higher the higher is the aggregate rural skill share, but the sectoral skill share decreases over time due to inflows of unskilled farmers from traditional agriculture. The higher the degree of constraints in agriculture (lower rural skill share), the weaker is the link between supermarkets and commercial farmers (measured by the average share of supply to supermarkets by domestic farmers). In addition, the magnitude of the supermarkets' demand shift towards foreign suppliers increases with the extent of constraints in the agricultural sector. Of course, supermarkets' dependence on local farmers is also affected by the chosen elasticity of substitution between domestic and foreign agricultural goods. The better the substitution possibilities, the larger is the demand shift towards foreign suppliers.

The mechanisms emphasized in this section (and in section 4) offer a possible interpretation of the conflicting evidence in the empirical literature with respect to the impact of supermarkets on local agriculture. Based on numerical simulations, we have seen that depending on the extent of local constraints related to market access and production capacity, entry of supermarket chains may be good or bad news for agriculture. When the agricultural sector is relatively developed, we identify positive interactions between local farmers and the supermarket sector. Farmers benefit from the supermarket expansion through productivity spillovers and increased demand, while supermarkets take advantage of relatively productive local suppliers. The strong linkage with the supermarket sector stimulates productivity spillovers and strengthens the degree of technological catch up in commercial agriculture. When the agricultural sector is less developed and faces local constraints, farmers do not meet the required standards of supermarkets and get stuck in a low productivity trap with technological divergence. In this case, supermarkets become increasingly dependent on foreign suppliers, and this further weakens the chances of domestic farmers to escape the low productivity trap. The endogenous interaction between agricultural productivity and supermarkets' choice of suppliers acts to reinforce dynamic processes, either decreasing the chances of escaping a low productivity trap or strengthening technological catch-up.

6. Supply chain development initiated by supermarkets

The starting point of this section is a less developed agricultural sector where farmers face constraints with respect to production capacity and market access (the rural skill share is set to 3%). Local farmers are stuck in a low productivity trap, and supermarkets are highly dependent on foreign suppliers (as illustrated in the previous section). To avoid transportation costs related to the use of foreign agricultural goods, supermarkets have an incentive to improve the productivity of local farmers. Supply chain development driven by the supermarket sector may include sub-contracting, training, credit access and improvement of organizational structure, among other factors. Farm assistance programs obviously involve costs for the supermarkets. In this section we identify the consequences of such investments for both supermarkets and local farmers. Supply chain

development is modeled as an exogenous increase in the rural skill share, from an initial level of 3% which stabilizes at 25% after 30 years. To quantify the macroeconomic effects of agricultural skill upgrading, we compare this scenario to the local constraints scenario where the rural skill share is constant at 3%.

The impact on productivity growth in commercial agriculture is illustrated in Figure 3. Supply chain development increases the sectoral skill share and improves the ability of commercial farmers to benefit from productivity spillovers. Without skill upgrading the sector is stuck in a low productivity trap with technological divergence (see also Figure 2 in section 5). When supermarkets contribute to supply chain development the productivity growth rate gradually increases and we observe technological catch-up towards the world agricultural frontier. Relative productivity increases from an initial level of 33% to 40% after 25 years, compared to 30% in the scenario without skill upgrading. Obviously, the quantitative effect depends on the chosen elasticities in the productivity specification, but sensitivity analyses show that within standard parameterization supply chain development contributes to technological catch-up. The increase in relative productivity in 2015 due to agricultural skill upgrading lies in the range 7-12% points (compared to 10% points with our preferred parameter values). As seen in Figure 4, the improvement in the relative productivity of domestic farmers affects the supermarket's choice of suppliers. With supply chain development the shift towards foreign farmers is avoided and the dependence on local farmers remains high throughout the period (above 60%). This further strengthens the linkage between supermarkets and commercial agriculture, and contributes to the growth out of the low productivity trap.

Figure 3 and 4 about here.

It is not surprising that commercial farmers benefit from farm assistance programs initiated by supermarkets. The consequences for the supermarket sector are more complicated. On the one hand, agricultural skill upgrading involves costs[14], but on the other hand, supermarkets may benefit from more productive local farmers. Along the

[14] See equations (5) and (6) in section 3.

transition path the skill upgrading costs account for 20-35% of the production value of supermarkets. Figure 5 illustrates the market share of supermarkets in food retail production in the two scenarios. While supply chain development implies a short run cost, supermarkets gradually gain from more productive local suppliers. The supermarket expansion is initially held back by increased costs, but the long-run effect of agricultural skill upgrading is positive for the supermarket sector. After 25 years the market share is about 6% points higher than in the scenario without skill upgrading. The result shows that supermarkets benefit from more productive farmers domestically, and supports the assumption that the sector has an incentive to invest in programs that improve the productivity of local suppliers.

The quantitative results depend on parameter assumptions in the model calibration. In particular, the parameter v in equation (6) is important for the magnitude of the supermarket's costs related to supply chain development. The negative value of the parameter equals the elasticity of cst_t with respect to the growth rate of rural skilled labor, where cst_t is the share of supermarket production value remaining after costs to supply chain development are paid. The lower cst_t is, the higher are the costs to skill upgrading. In the base-run simulations we set $v = 0.2$, which means that if the growth rate of rural skilled labor increases by 1%, cst_t falls by 0.2%. For instance, if the growth rate increases by 1% point from 2% to 3% (50% increase), cst_t falls by 10% (from 1 to 0.9). This corresponds to skill upgrading costs accounting for 10% of the production value of supermarkets. Based on sensitivity analyses, the finding that supermarkets face a short run cost and long run gain from agricultural skill upgrading is robust to different values of the cost parameter (within reasonable ranges). The elasticity of substitution between domestic and foreign commercial goods affects the supermarkets' dependence on local farmers. The harder it is to substitute towards foreign farmers, the larger is the incentive of supermarkets to contribute to agricultural skill upgrading (measured by the increase in the long-run market share).

Figure 5 about here.

The main findings in this section are consistent with existing empirical evidence. Weatherspoon and Reardon (2003) discuss the procurement system of South African supermarket chains dominating the African market. First, they find that supermarkets prefer large farmers as suppliers, because they are likely to be more productive and familiar with quality and safety standards from own exporting activity. When such large suppliers are not available and small farmers do not meet the required standards, supermarkets tend to import necessary agricultural goods. Second, the analysis supports the skill upgrading incentive of the supermarket sector: "Where projects can be put in place to 'upgrade' the small farmers to meet the needs of supermarkets, the chains appear to be eager to participate in these schemes" (page 352). As discussed by Minten et al. (2009), the agricultural sector in Madagascar is characterized by significant local constraints including bad infrastructure, low rural education, and high transaction costs. Their analysis shows that farm assistance programs have made farmers capable of supplying foreign supermarkets. Based on survey data from several Eastern European countries, Swinnen et al. (2006) find that foreign direct investment in the dairy sector has contributed to contracting and vertical coordination with farmers. Evidence shows that both small and large farmers benefit from the entry of foreign retail chains. Dries and Swinnen (2004) find that contracting and supplier assistance programs led to improvements in investments, productivity and product quality of small farmers in the dairy sector in Poland. The analysis documents a positive interaction between the foreign company and local suppliers, consistent with the results in the present paper.

7. Conclusion

As part of the globalization process, multinational supermarket chains enter the markets of developing countries, both in Latin America, Asia and most recently in Africa. There is no consensus in the empirical literature on whether the agricultural sector benefits from the presence of supermarkets. Empirical analyses find that supermarkets represent both opportunities and challenges for local farmers. Our contribution is the construction and calibration of a Ramsey growth model to identify the consequences of supermarket expansion for agricultural productivity and structural change. The methodological

approach clarifies the underlying adjustment mechanisms involved, and allows for endogenous interaction between agricultural productivity and supermarkets' dependence on local suppliers. Numerical simulations show how the two-way relationship between supermarkets and local farmers acts to reinforce dynamic processes, either decreasing the chances of escaping a low productivity trap or strengthening technological catch-up. This kind of model simulation supplements econometric analyses that struggle with causality issues and are unclear about the channel of effects.

Our incorporation of the productivity linkage between supermarkets and local farmers offers a possible interpretation of the conflicting results in the empirical literature: depending on the extent of local constraints related to production capacity and market access, farmers either benefit from supermarkets through productivity spillovers and increased demand, or they get stuck in a low productivity trap with limited interaction with the supermarket sector. Supply chain development initiated by supermarkets can help farmers escape the low productivity trap. Supermarkets face a short run cost, but gradually benefit from the agricultural skill upgrading in terms of increased market share. Our result suggests that when farmers do not meet the required standards, supermarkets have an incentive to invest in farm assistance programs that improve the productivity of local suppliers. The main findings in the simulation analysis are consistent with case studies in the literature.

This analysis has focused on the potential productivity gain from delivering agricultural goods to multinational supermarket chains. Of course, other factors than the productivity linkage might be important to identify the full effect of supermarket expansion on local agriculture. Future research should take other potential mechanisms into account and quantify the relative importance of the productivity channel.

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Figure 1: Productivity dynamics.
i) High level of absorptive capacity: Technological catch-up and constant long-run gap
ii) Low level of absorptive capacity: Technological divergence and increasing gap

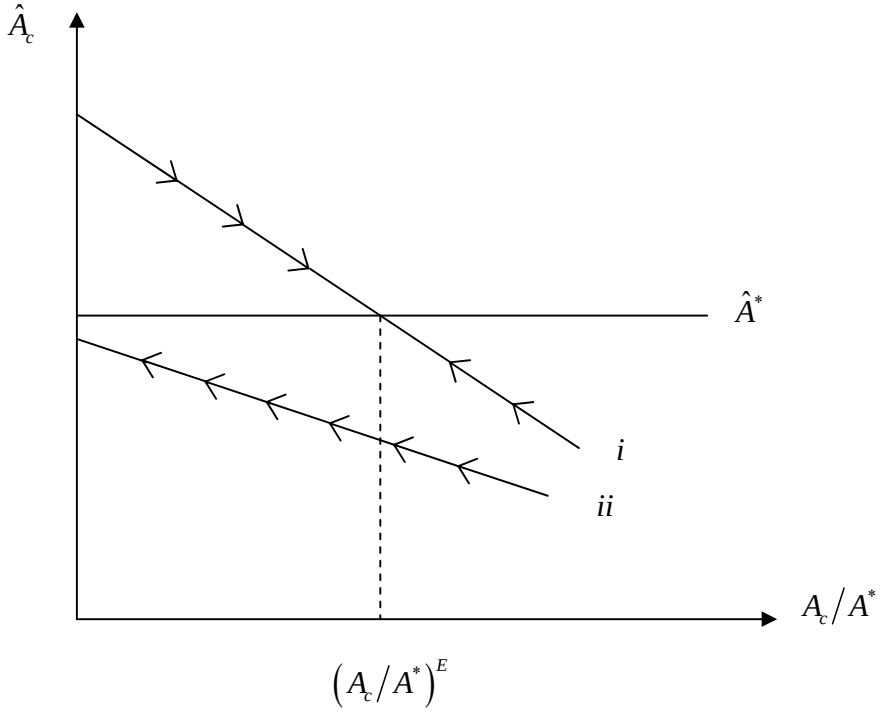

Figure 2. Productivity level in commercial agriculture relative to the agricultural technology frontier: Relatively well-developed agricultural sector (reference path) vs. farmers facing local constraints.

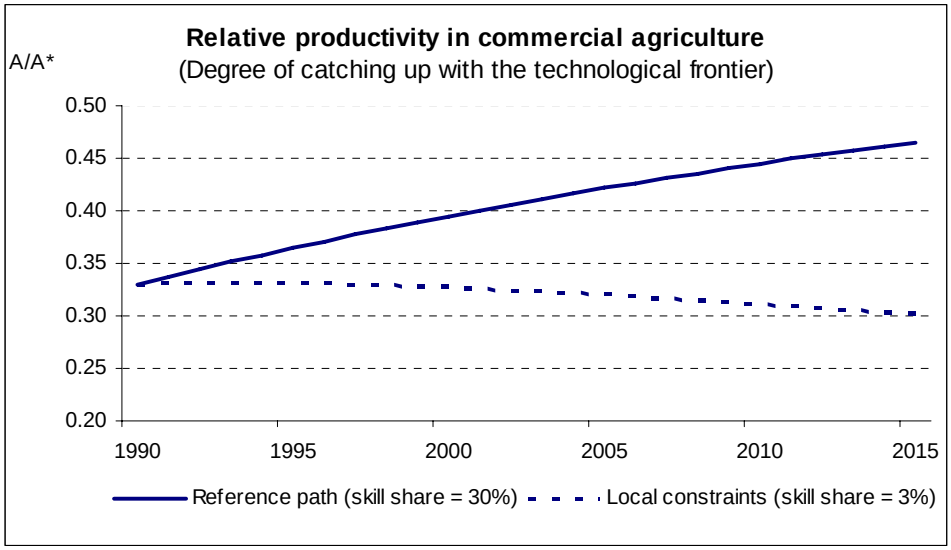

Figure 3. Productivity growth in commercial agriculture: Farmers facing local constraints (rural skill share at 3%) vs. supply chain development initiated by supermarkets (gradual increase in the rural skill share from 3% to 25%).

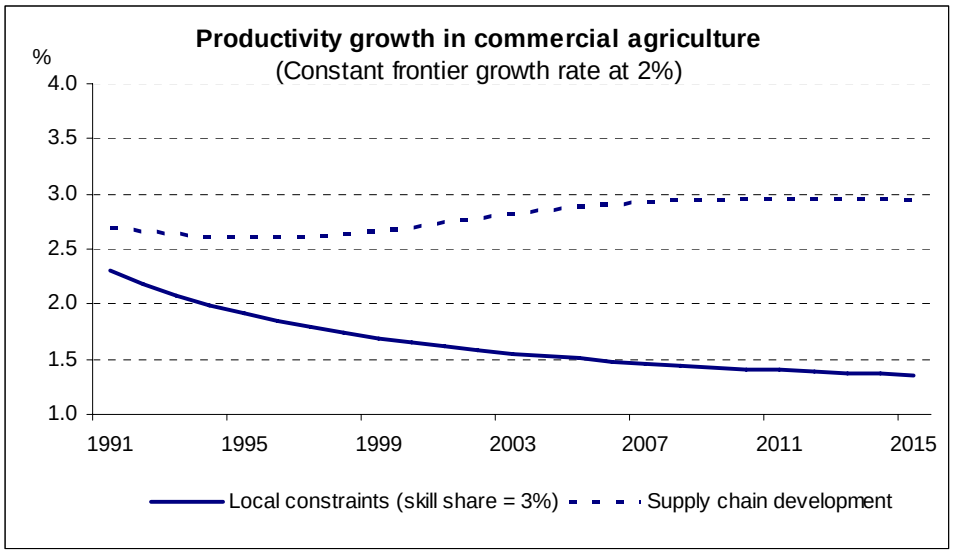

Figure 4. Share of supply to supermarkets from domestic farmers: Farmers facing local constraints (rural skill share at 3%) vs. supply chain development initiated by supermarkets (gradual increase in the rural skill share from 3% to 25%).

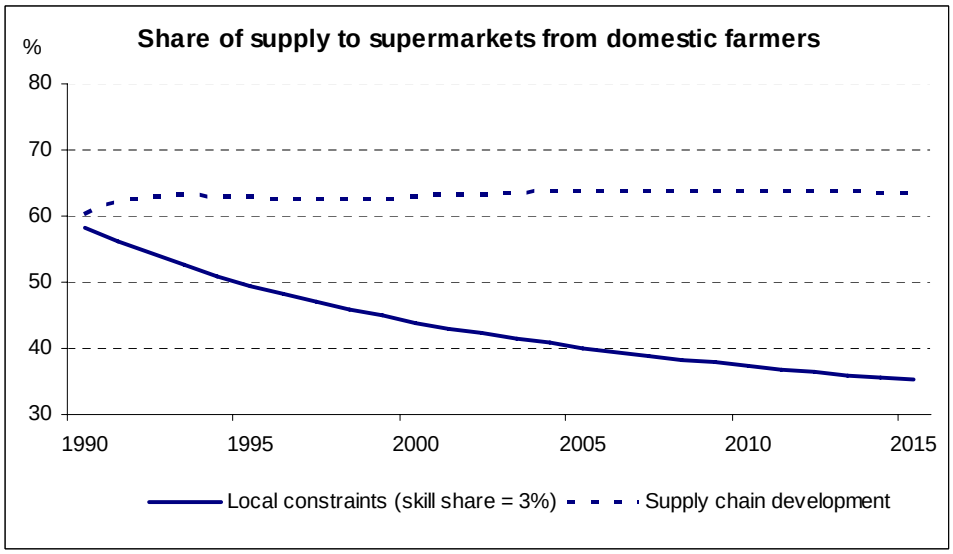

Figure 5. Supermarket expansion: Farmers facing local constraints (rural skill share at 3%) vs. supply chain development initiated by supermarkets (gradual increase in the rural skill share from 3% to 25%).

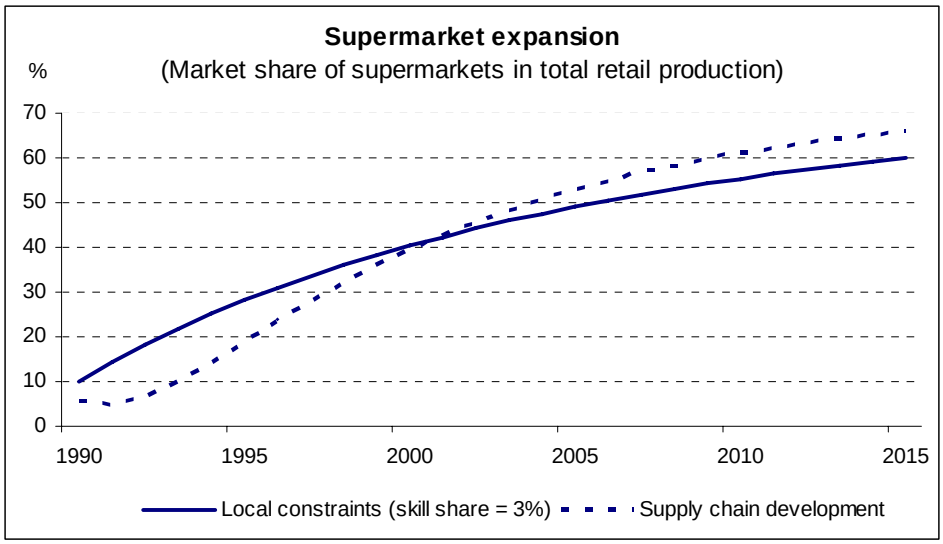

Table 1. Simulation results for different values of the aggregate rural skill share.

Aggregate rural skill share	Degree of technological catch-up	Share of supply to supermarkets from domestic farmers[1]	Skill share in commercial agriculture[1]
3 %	-3 % points	43 %	15 %
5 %	0 % point	49 %	22 %
10 %	4.5 % points	58 %	35 %
15 %	8 % points	63 %	45 %
20 %	10 % points	66 %	54 %
25 %	12 % points	68 %	61 %
30 %	14 % points	70 %	67 %

[1] The given statistics refer to the average level during 1990-2015 in the model simulations.