# Land Market Integration, Structural Change, and Smallholder Farming in Zambia

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**Abstract**

The bifurcation of Zambia's agricultural land markets prevents smallholder farmers from participating in modern food marketing channels. High transaction costs in terms of time and financial resources make conversion of customary land into commercial land title prohibitively expensive for smallholder farmers. The simulated conversion of land title, without changing ownership, instigates a reallocation of capital and labor resources in the modeled economy that benefits smallholders in their roles as producers and household owners of factors of production. With the increase in commercial land area, labor becomes scarce and farm production becomes more capital intensive, thus increasing labor productivity and smallholder household income. This analysis highlights the importance of integrating land markets and giving smallholders an effective increase in the range of their resource allocation decisions.

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# 1 Introduction

The world has recently witnessed the beginnings of a remarkable transition in emerging economies from traditional food marketing channels to commercial channels employing the technology common to advanced countries. Modern, commercial food marketing channels have been growing rapidly compared to traditional food marketing channels in economies across Latin and South America, south east Asia, and parts of Africa (Weatherspoon and Reardon 2003). This paper examines, from the point of view of structural adjustment, the effect of agricultural land market integration on traditional sector Zambian smallholder farmers.

In the course of economic development, farms and food marketing firms introduce more capital intensive methods of production along with new technologies. As a result, labor productivity rises in the modern relatively capital intensive sectors, with the tendency to pull labor from the traditional sector. Thus, the evolution of the modern food marketing channel instigates changes in the allocation of capital and other resources (Roe and Diao 2004). However, many of these economies feature missing markets that, in the process of transition growth, can adversely affect the traditional farm sector due to high transaction costs and transaction risks (Emongor 2008, Dorward, Kydd, Morrsion, and Urey 2004).

For this, and perhaps other reasons, such as the lack of well-defined and enforceable property rights and problems with contract enforcement (Bellemare 2013), land in traditional farms tends not to be rented out to the owners of commercial farms. Consequently, the transition to more modern marketing channels servicing modern supermarkets can be particularly worrisome to owners of land in traditional farms. This effect is possibly made more onerous when, as numerous studies suggest (Stokke 2009, Weatherspoon and Reardon 2003), the rate of transition from modern to traditional channels appears to be occurring at a pace that exceeds the historical pace experienced in today's advanced economies (Reardon et al. 2003). Results from this paper's agricultural land market analysis show that smallholders would benefit from a less costly process of converting from customary to freeshold title.

# 2 Zambia in Transition

In this paper, we select the economy of Zambia because it is in the early stages of the transition process from traditional food channels to modern, commercial channels. Zambia represents a modern copper and other base metal mining and refining industry set in the environment of a traditional agrarian economy. The capital intensive mining industry, which earns most of Zambia's foreign exchange, also generates some intermediate processing and fabrication of the metals. Although the mining industry is dominant, it employs relatively few workers compared to the agricultural sector.

Zambia falls in the low income group of nations with a GNI of US$12.5 billion and total population of 12.9 million in 2009. Life expectancy at birth was 45 years compared to the low income group average of 57. GNI per capita was US$960 versus US$1,126 for sub-Saharan Africa and US$512 for low income nations.

As a percentage of GDP, the structure of the Zambian economy consists of services–44.3%, industry–34.1% of which manufacturing is 9.6%, and agriculture–21.6%. The primary industries are base metal mining and metal refining. The leading exports are copper, cobalt, electricity, tobacco, flowers, cotton, copper cables, maize and sugar. Leading imports include machinery, transportation equipment, petroleum products, fertilizer, food stuffs, and clothing. While Zambia is highly urbanized, especially in Copperbelt province, agriculture represents about 85% of employment.

In colonial times, white settlers farmed large estates found along the line of rail. In comparison, the average smallholder farm is just a few hectares. This legacy is part of the story of the bifurcation of Zambian food channels. Smallholder farmers, because of their small scale, low levels of education, and geographic dispersion from the benefits of infrastructure and larger markets, face higher transaction costs that inhibit competition (Ortmann and King, 2010). Because they are not integrated, agricultural land markets in Zambia present roadblocks to smallholder farmers seeking to gain entry into modern food marketing channels. Zambia's two agricultural sectors are based on different systems of land tenure. Smallholders farm about 93% of Zambia's farmland, which is organized under customary land tenure. Tribal chiefs retain authority over this land. Commercial farmers own the remaining 7%, which is organized under freehold title, allowing them to buy and sell and take out mortgages. Although land title conversion is legal in Zambia, it is prohibitively expensive for smallholders in terms of time and financial cost.

The goal of this paper is to explore the structural effects, and particularly the effects on smallholder profits, on the Zambian economy of a conversion of a quarter of customary lands to freehold status. Such a conversion does not imply a change in ownership or payments of rents and profits, but simply a change in sector status from traditional farming to commercial farming. This study does not contemplate the specific mechanisms under which this conversion would occur, but examines the effects on the economic performance of Zambia's sectors.

The paper proceeds by describing the conceptual framework of a Ramsey growth model fitted to data on the Zambian economy and solved with Mathematica. Model parameters are derived from a 1995 social accounting matrix (Hausner, 1999). The model is customized with two farming sectors and two food retail marketing sectors. Next, the baseline model is adjusted for the land conversion scenario with changes to two statistics–land area and output. The baseline model is then compared with the land title conversion scenario described in the previous paragraph. The empirical results show that land conversion increases smallholder and commercial demand for labor while the capital market faces a variety of effects on the supply and demand sides. The paper concludes with a discussion of policy recommendations.

# 3 The Model

## 3.1 Environment

- The economy produces four final goods, denoted $Y_j$, a manufactured good, $Y_m$, a service good, $Y_s$ and two food goods, one of which is provided by modern food retail firms, $Y_r$, the other by traditional food retail firms, $Y_d$.

- Two agricultural goods, and their accompanying wholesale - processing - distribution services, are produced that supply the food retail sector. This vertical production - processing - distribution chain is bifurcated, one of which mostly supplies modern food retail markets, the other of which mostly supplies the traditional food retail firms. The modern food retail firms are supplied by the commercial - modern farms - modern food processing and distribution system. Denote this supply by $Y_c$. Traditional food retail firms are supplied by the more traditional

farm-food processing and distribution system. Denote this supply by $Y_h$.

- The markets for the service good $Y_s$, retail food $Y_r$ and $Y_d$ are domestic only. That is, international trade does not occur at the retail level for these goods so that their prices, denoted $p_s$, $p_r$, $p_d$, respectively, are endogenous. International trade occurs for the manufactured good $Y_m$ at a given world price $p_m$, and at the wholesale level for the modern agricultural good $Y_c$ at the given world price $p_c$. However, it is assumed that the traditional farm-food processing distribution chain is confined to the domestic market only and hence does not engage in foreign trade. Thus, the supply produced by this chain $Y_h$ is traded at a domestic price $p_h$ that is endogenously determined.

- All technologies are neo-classical constant returns to scale, and all markets are competitive.

- The current generation of households behave as though they take into account the welfare and resources of their descendents. Household members are assumed to grow at the rate $n$ over time. Households receive payments $w$ and $r^k$ for the service flows of their stock of labor $L$ and capital $K$, and rental payments $\pi_c$ and $\pi_h$ for the service flows of the land endowments $H_m$ and $H_t$ in modern and traditional agriculture, respectively. They exchange this income stream for expenditures on consumption goods $Q_j, j = m$ (manufactures), $r$ (modern retail food), $d$ (traditional retail food), $s$ (services) and savings.

## 3.2 Households

Households are represented by an infinitely-lived Ramsey model where preferences for final goods $y_m, y_r, y_d, y_s$ in per worker terms are expressed in the following utility function. Households receive utility from the sequence $\{q_m, q_r, q_d, q_s\}_{t=0}^{t=\infty}$expressed as a weighted sum of all future flows of utility

$$\int_{t=0}^{t=\infty} \frac{u(q_m, q_r, q_d, q_s)^{1-\theta} - 1}{1-\theta} e^{(n-\rho)t} dt \tag{1}$$

The felicity function $u(\cdot)$ is assumed to be of the Stone-Geary form. Households, assumed to be proportional to the number of workers, grow at the rate

$$L(t) = e^{nt}L(0) \tag{2}$$

and discount future consumption at the rate $\rho > 0$. The ratio $1/\theta$ represents the inter-temporal elasticity of substitution, where we presume $\theta \geq 1$.

The household's flow budget constraint expresses savings $\dot{K}$ at each instant in time as the difference between income(wages and interest) and expenditure on final goods. Foreign ownership of assets is not allowed so that the stock of capital assets equals the the economy's stock of capital $K$. Its budget constraint is

$$\dot{k} = w + k(r - n) + \pi_c H_c + \pi_h H_h - E \tag{3}$$

where expenditures on final goods is given by

$$E = \varepsilon(p_m, p_r, p_d, p_s)q + \gamma_r p_r + \gamma_d p_d = \underset{\{q_j \geq 0\}}{Min} \left\{ \sum_j p_j q_j \mid q \leq \mu(q_m, q_r - \gamma_r, q_d - \gamma_d, q_s) \right\} \tag{4}$$

The implied no-arbitrage condition between capital and land for each agricultural sector must hold at each instant in time such that the return to capital equals the profits to agricultural land plus appreciation in the price of land where $P_{Li}$ is the price of land.

$$r = \frac{\pi_i}{P_{L_i}} + \frac{\dot{P}_{L_i}}{P_{Li}}, i = c, h \tag{5}$$

The first order conditions obtained from the present-value Hamiltonian yield the Euler equation,

$$\frac{\dot{q}}{q} = \frac{1}{\theta}(r - \rho - \sum_{j=r,d,s} \lambda_j \frac{\dot{p}_j}{p_j}) \tag{6}$$

where $\lambda_i$ is the share of super numerary expenditure $\varepsilon(p_m, p_r, p_d, p_s)q$ allocated to the $i - th$ good

$$\lambda_i = \frac{\varepsilon_{p_j} p_j}{\varepsilon(\cdot)}, \ j = r, dd, s$$

where $\varepsilon_{p_j} = \partial\varepsilon(\cdot)/\partial p_j$. This relationship means that households will choose a series of expenditures equal to the difference between the return on their

assets $r$ their rate of time preference $\rho$ and the weighted change in prices $p_j$. Households displaying a relatively high time preference (and small $(r-\rho)$ ) will experience a small growth rate in expenditures; they have little incentive to forgo consumption.

## 3.3 Firms

### 3.3.1 Manufacturing and service sector firms

The manufacturing and service producing firms employ neoclassical and constant returns to scale technologies

$$Y_j = Min\left\{\mathcal{F}^j\left(\mathcal{A}L_j, K_j\right), \frac{Y_{mj}}{\sigma_{mj}}, \frac{Y_{sj}}{\sigma_{sj}}, \frac{Y_{c,j}}{\sigma_{c,j}}\right\},\ j = m, s \tag{7}$$

that employ the services of labor $L_j$ and capital $K_j$, and intermediate factor flows $Y_{ij}$, where $\mathcal{A} = e^{xt}$ and $x$ is the exogenous rate of factor augmentation. Expressing the technology in intensive form (i.e. in units of effective - economy wide workers $\mathcal{A}L$) yields

$$\hat{y}_j = Min\left\{\mathcal{F}^j\left(l_j, \hat{k}_j\right), \frac{\hat{y}_{mj}}{\sigma_{mj}}, \frac{\hat{y}_{sj}}{\sigma_{sj}}, \frac{\hat{y}_{c,j}}{\sigma_{cj}}\right\},\ j = m, s$$

where $l_j = \mathcal{A}L_j/\mathcal{A}L$ and $\sigma_{ij}$ are input-output coefficients that determine the amount of intermediate input $Y_{ij}$required to produce one unit of $Y_j$ output. Firms behave to minimize cost subject to their technology, yielding, for $j = m, s$

$$\left(C^j\left(\hat{w}, r^k\right) + \sum_{i=m,s,c} p_i\sigma_{ij}\right)\hat{y}_j \equiv \underset{l_j,\hat{k}_j,\hat{y}_{mj},\hat{y}_{sj},\hat{y}_{c,j}}{Min}$$

$$l_j\hat{w} + r^k\hat{k}_j + \sum_{i=m,s,c} p_j\sigma_{ij}\hat{y}_{ij} \mid \hat{y}_j = Min\left\{\mathcal{F}^j\left(l_j, \hat{k}_j\right), \frac{\hat{y}_{mj}}{\sigma_{mj}}, \frac{\hat{y}_{sj}}{\sigma_{sj}}, \frac{\hat{y}_{c,j}}{\sigma_{c,j}}\right\}$$

### 3.3.2 The agricultural-food processing distribution chain

The modern agricultural-food processing distribution chain employs a neoclassical and constant returns to scale technology

$$Y_c = Min\left\{\mathcal{F}^c\left(\mathcal{A}L_c, K_c, \mathcal{B}H_c\right), \frac{Y_{mc}}{\sigma_{mc}}, \frac{Y_{sc}}{\sigma_{sc}}, \frac{Y_{cc}}{\sigma_{cc}}\right\} \tag{8}$$

where $\mathcal{B} = e^{\gamma t}$ and $\gamma$ is the exogenous rate of factor (e.g., land) augmentation due to improvements in agronomic and other practices affecting the productivity of the sector specific factor $H_c$. Since $H_c$ is specific to the sector, it is convenient to express aggregate firm behavior at the sector level as

$$\pi_c = \pi^c \left( pv_c, \hat{w}, r^k \right) H_c \equiv$$

$$\underset{l_c, k_c}{Max} \left\{ \left( p_c - \sum_{i=m,s,c} p_i \sigma_{ic} \right) \hat{y}_c - \hat{w} l_c - r^k \hat{k}_c \right\}$$

subject to (8) expressed in intensive form, i.e., in units of effective economy wide labor. The value added price $pv_c$ is defined as

$$pv_c = pv^c \left( p_c, p_m, p_s \right) \equiv p_c - \sum_{i=m,s,c} p_i \sigma_{i,c}$$

For simplicity at this point, we impose the condition that the rate of factor productivity growth of land equal the rate of labor productivity growth plus the rate of growth of the work force, $n = \dot{L}/L$, i.e., $\gamma = x + n$.

The traditional agricultural-food processing distribution chain behaves in the same manner as the modern chain, albeit with same functional form for technology but different parameters to capture the relatively more labor intensive nature of this chain, and its lessor reliance on service inputs $Y_{sh}$. Firms in this sector employ a neoclassical and constant returns to scale technology

$$Y_h = Min \left\{ \mathcal{F}^h \left( \mathcal{A} L_h, K_h, \mathcal{B} H_h \right), \frac{Y_{mh}}{\sigma_{mh}}, \frac{Y_{sh}}{\sigma_{sh}}, \frac{Y_{hh}}{\sigma_{hh}} \right\} \tag{9}$$

where $\mathcal{B} = e^{\gamma t}$ and $\gamma$ is the exogenous rate of factor (e.g., land) augmentation due to improvements in agronomic and other practices affecting the productivity of the sector specific factor $H_h$. Since $H_h$ is specific to the sector, it is convenient to express, aggregate firm behavior at the sector level as

$$\pi^h \left( pv_h, \hat{w}, r^k \right) H_h \equiv$$

$$\underset{l_h, k_h}{Max} \left\{ \left( p_h - \sum_{i=m,s,h} p_i \sigma_{ih} \right) \hat{y}_h - \hat{w} l_h - r^k \hat{k}_h \right\} \tag{10}$$

subject to (9) expressed in intensive form, i.e., in units of effective economy wide labor. The value added price $pv_h$ is defined as

$$pv_h = pv^h\left(p_h, p_m, p_s\right) \equiv p_h - \sum_{i=m,s,h} p_i \sigma_{ih}$$

Again, we impose the condition that the rate of factor productivity growth of land equal the rate of labor productivity growth plus the rate of growth of the work force, $n = \dot{L}/L$, i.e., $\gamma = x + n$.

### 3.3.3 The modern and traditional retail-food firms

Modern retail food firms employ a constant returns to scale neoclassical technology

$$Y_r = Min\left\{\mathcal{F}^r\left(\mathcal{A}L_r, K_r, Y_{cr}\right), \frac{Y_{mr}}{\sigma_{mr}}, \frac{Y_{sr}}{\sigma_{sr}}\right\}$$

employing labor $L_r$, capital $K_r$ and wholesale-level food $Y_{cr}$, that we assume initially (and relax later), is only produced by the modern farm - processing - distribution chain of firms. As in the case of manufacturing and service sectors, cost minimization leads to

$$\left(C^r\left(\hat{w}, r^k, p_c\right) + \sum_{i=m,s} p_i \sigma_{i,r}\right)\hat{y}_r$$

Similarly, for the traditional retail food firms, we have the technology

$$Y_d = Min\left\{\mathcal{F}^d\left(\mathcal{A}L_d, K_d, Y_{hd}\right), \frac{Y_{md}}{\sigma_{md}}, \frac{Y_{sd}}{\sigma_{sd}}\right\}$$

which implies the cost function, per effective worker units,

$$\left(C^d\left(\hat{w}, r^k, p_h\right) + \sum_{i=m,s} p_i \sigma_{id}\right)\hat{y}_d$$

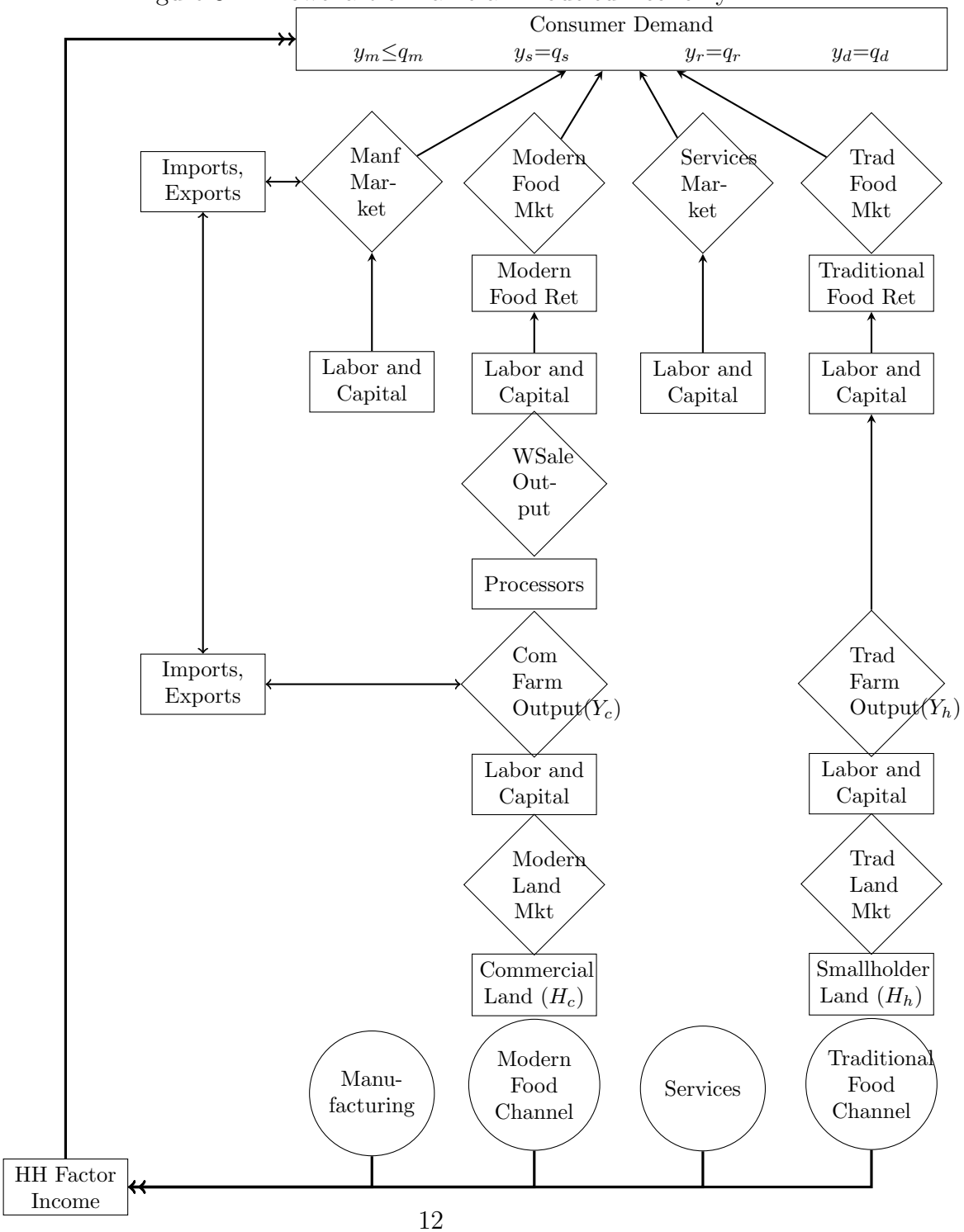
In this case however, $p_h$ is endogenous.

### 3.3.4 Summary

Figure 3.1 depicts the main features of the modeled four-sector economy. Agricultural food-processing distribution chains, as described above, outline the economic structure of their respective vertical marketing channels as shown in the traditional and modern food channels. At the farm level, output is represented by a production function consisting of labor, capital and land inputs. The particular technology employed in each sector determines the scale of contribution of each of the factors. Cost minimizing firms choose the production process with the most efficient combination of factors. Intermediate inputs are assumed to contribute to production in a Leontief fashion. At the beginning of the chain are the service flows of primary factor inputs. At the end of the agricultural segment of the marketing chain is derived demand for agricultural produce at market-clearing prices. The difference between the price of output and the cost of intermediate inputs is the value added by the firm. As product moves upward from farm to retail, firms add value at each stage of production (Stern 1988). The value added price represents the contribution of the firm to the overall final output value. In various degrees, depending on the levels of technology and the factors employed, food marketing channels add value at each successive stage of production as the product moves further away from its original status as a primary commodity (Kislev and Peterson 1982). At the farm level, food products exhibit characteristics of commodities, while as they move through the marketing channel they acquire other characteristics such as place, time, and form. The modern food marketing channel, as the data presented later shows, tends to be relatively more capital intensive than is the case of the traditional channel. Moreover, due to uniformity of product and resources to assemble and distribute product, the commercial farm-wholesale market is presumed to have access to foreign markets so that a constant and given world market price $p_c$ prevails. The traditional farm-wholesale sector is presumed to supply domestic markets only so that the price $p_h$ endogenous.

This structure causes growth in the rest of the economy to impact the modern and traditional sector in different ways. As capital deepening occurs, the manufacturing and service sectors compete for resources, causing wages relative to capital rents to rise. Since, as the data suggest, the commercial farm-wholesale-retail channel is relatively more capital intensive than the traditional channel, capital deepening can cause unit costs of the traditional relative to the modern channel to rise thus, all else constant, increasing the

Figure 3.1: Flowchart of Zambian Modeled Economy



marketing margin between traditional farm to retail outlet. This increasing margin can depress the price received by traditional farmers relative to the price received by farmers in the modern sector while at the same time increasing the retail price of food in the traditional relative to modern food retail outlets. Effectively, capital deepening can lead to negative terms of trade effects on the traditional sector causing, to the extent resources are mobile, resources to depart the traditional sector.

## 3.4 Definition and Characterization of Equilibrium

Given the initial prices, $p_s(0), p_h(0), p_r(0), p_d(0)$, resource endowments $\{K(0), L(0), H(0)\}$ and constant world market prices, $p_m, p_c$, a competitive equilibrium is a sequence of positive prices

$$\{p_s(t), p_h(t), p_r(t), p_d(t)\}_{t\in[0,\infty)}$$

positive household consumption plans

$$\{\widehat{q}_m(t), \widehat{q}_r(t), \widehat{q}_d(t), \widehat{q}_s(t)\}_{t\in[0,\infty)}$$

positive factor rental prices

$$\{\widehat{w}(t), r(t), \widehat{\pi}_c(t), \widehat{\pi}_h(t)\}_{t\in[0,\infty)}$$

for labor, capital, the two types of agricultural land, respectively, and production

$$\{\widehat{y}_m(t), \widehat{y}_r(t), \widehat{y}_d(t), \widehat{y}_s(t), \widehat{y}_c(t), \widehat{y}_h(t)\}_{t\in[0,\infty)}$$

and resource allocation plans

$$\left\{\widehat{k}_m(t), \widehat{k}_r(t), \widehat{k}_s(t), \widehat{k}_d(t), \widehat{k}_c(t), \widehat{k}_h(t), \widehat{l}_m(t), \widehat{l}_r(t), \widehat{l}_s(t), \widehat{l}_d(t), \widehat{l}_c(t), \widehat{l}_h(t)\right\}_{t\in[0,\infty)}$$

such that at each instant of time *t,* households maximize utility subject to a budget contraint and firms maximize profit subject to technology and resource constraints.

It is convenient to characterize equilibrium in two parts, an intra-temporal and a temporal component.

### 3.4.1 Intra-temporal equilibrium

Given the sequence $\left\{\widehat{E}(t), \hat{k}(t)\right\}_{t\in[0,\infty)}$, intra-temporal equilibrium can be characterized by the following ten equations in ten unknowns

$$\Omega = (\widehat{w}, r^k, p_r, p_d, p_s, p_h, \widehat{y}_m, \widehat{y}_r, \widehat{y}_d, \widehat{y}_s) \tag{11}$$

Firms in the final goods sectors $m, r, d, s$, earn zero profits

$$c^m(\widehat{w}, r^k) - (p_m - \sigma_{mm}p_m - \sigma_{sm}p_s - \sigma_{cm}p_c) = 0 \tag{12}$$

$$c^r(\widehat{w}, r^k, p_c) - (p_r - \sigma_{mr}p_m - \sigma_{sr}p_s) = 0$$

$$c^d(\widehat{w}, r^k, p_h) - (p_d - \sigma_{md}p_m - \sigma_{sd}p_s) = 0$$

$$c^s(\widehat{w}, r^k) - (p_s - \sigma_{ms}p_m - \sigma_{ss}p_s - \sigma_{cs}p_c) = 0$$

Markets clear for:
Labor

$$c^m_w(\widehat{w}, r^k)\widehat{y}_m + c^r_w(\widehat{w}, r^k, p_c)\widehat{y}_r + c^d_w(\widehat{w}, r^k, p_h)\widehat{y}_d + c^s_w(\widehat{w}, r^k)\widehat{y}_s$$

$$-\pi^c_w(pv_c, \widehat{w}, r^k)\widehat{H}_c - \pi^h_w(pv_h, \widehat{w}, r^k)\widehat{H}_h = 1 \tag{13}$$

Capital

$$c^m_{r^k}(\widehat{w}, r^k)\widehat{y}_m + c^r_{r^k}(\widehat{w}, r^k, p_c)\widehat{y}_r + c^d_{r^k}(\widehat{w}, r^k, p_h)\widehat{y}_d + c^s_{r^k}(\widehat{w}, r^k)\widehat{y}_s$$

$$-\pi^c_{r^k}(pv_c, \widehat{w}, r^k)\widehat{H}_c - \pi^h_{r^k}(pv_h, \widehat{w}_s, r^k)\widehat{H}_h = \widehat{k} \tag{14}$$

and, the supply of the agricultural good produced on traditional farms equals intermediate demand[1]

$$\pi^h_{p_h}(pv_h, \widehat{w}, r^k)\widehat{H}_h - c^d_{p_h}(\widehat{w}, r^k, p_h)\widehat{y}_d = 0 \tag{15}$$

Demand and supply for final retail goods clear, for:

[1]The supply of the commercially produced agricultural good is an inequality because of the possibility of international trade.

the supermarket retail food market

$$\partial \widehat{E}/\partial p_r = \widehat{y}_r = \frac{\lambda_r \varepsilon(\cdot)\,\hat{q}}{p_r} + \gamma_r \tag{16}$$

the traditional retail food market

$$\partial \widehat{E}/\partial p_d = \widehat{y}_d = \frac{\lambda_d \varepsilon(\cdot)\,\hat{q}}{p_d} + \gamma_d \tag{17}$$

and the service good market

$$\partial \widehat{E}/\partial p_s = \frac{\lambda_s \varepsilon(\cdot)\,q}{p_s} = \widehat{y}_s - \sigma_{ss}\hat{y}_s - \sigma_{sm}\hat{y}_m - \sigma_{sc}\hat{y}_c - \sigma_{sh}\hat{y}_h \tag{18}$$

where, upon substituting the reduced forms (19) for $\hat{w}$ and $r^k$, we have the supply functions for commercial and traditional agriculture which, to lower notational clutter, are expressed as a function of the endogenous variables $p_s$, and $p_h$ only

$$\begin{aligned} \hat{y}_c &= \tilde{y}^c(p_s, p_h) \equiv \frac{\partial \pi^c(pv_c, \widehat{w}, r^k)\widehat{H}_c}{\partial pv_c} \\ \hat{y}_h &= \tilde{y}^h(p_s, p_h) \equiv \frac{\partial \pi^h(pv_h, \widehat{w}, r^k)\widehat{H}_h}{\partial pv_h} \end{aligned}$$

To derive the model's equation of motion, it is useful to reduce the dimensionality of the intra-temporal conditions.

### 3.4.2 Reducing the dimensionality of the system

We first express the four zero profit conditions (12) in the six unknowns $\{\widehat{w}, r^k, p_r, p_d, p_s, p_h\}$ as functions of $p_s$ and $p_h$:

$$\left\{\hat{w} = W(p_s, p_h),\ r^k = R(p_s, p_h),\ p_r = P^r(p_s, p_h),\ p_d = P^d(p_s, p_h)\right\} \tag{19}$$

Next, through expenditure, $\widehat{E}$, use the relationship between final demand for modern retail food (16) and traditional retail food(17) and solve for modern retail output, $\widehat{y}_r$

$$\hat{y}_r = \frac{\lambda_r}{\lambda_d}\frac{p_d}{p_r}(\widehat{y}_d - \gamma_d) + \gamma_r \tag{20}$$

With this result, we substitute for $\widehat{y}_r$ into new factor market clearing equations.

This gives us three equations that are linear in $\hat{y}_m, \hat{y}_d$, and $\hat{y}_s$ which we solve and express as a function of endogenous variables only:

$$\begin{aligned} \hat{y}_m &= \tilde{y}^m\left(p_s, p_h, \hat{k}\right) \\ \hat{y}_s &= \tilde{y}^s\left(p_s, p_h, \hat{k}\right) \\ \hat{y}_d &= \tilde{y}^d\left(p_s, p_h, \hat{k}\right) \end{aligned} \tag{21}$$

and thus

$$\hat{y}_r = \tilde{y}^r\left(p_s, p_h, \hat{k}\right) = \frac{\lambda_r}{\lambda_d}\frac{P^d\left(p_s, p_h\right)}{P^r\left(p_s, p_h\right)}\left(\tilde{y}^d\left(p_s, p_h, \hat{k}\right) - \gamma_d\right) + \gamma_r \tag{22}$$

From the home good market clearing condition (18), we have

$$\tilde{\varepsilon}\left(p_m, p_h, p_s\right) q = \frac{p_s}{\lambda_s}\bar{Y}^s\left(p_s, p_h\hat{k}\right) \tag{23}$$

where

$$\bar{Y}^s\left(p_s, p_h\hat{k}\right) \equiv \left(\left(1-\sigma_{ss}\right)\tilde{y}^s\left(p_s, p_h, \hat{k}\right) - \sigma_{sm}\tilde{y}^m\left(p_s, p_h, \hat{k}\right) - \sigma_{sc}\tilde{y}^c\left(p_s, p_h\right) - \sigma_{sh}\tilde{y}^h\left(p_s, p_h\right)\right)$$

and

$$\tilde{\varepsilon}\left(p_m, p_h, p_s\right) = \varepsilon\left(p_m, P^r\left(p_s, p_h\right), P^d\left(p_s, p_h\right), p_s\right)$$

### 3.4.3 The Steady state

We first substitute reduced forms (19) for $\hat{w}$ and $r^k$, the supply functions,(21) and (23) into the budget constraint to obtain

$$\dot{\hat{k}} = \mathbf{K}\left(p_s, p_h, \hat{k}\right) \equiv \tag{24}$$

$$W\left(p_s, p_h\right) + R\left(p_s, p_h\right)\left(\hat{k} - x - \delta - n\right) + \widetilde{\pi}^c\left(p_s, p_h\right) H_c + \widetilde{\pi}^h\left(p_s, p_h\right) H_h -$$

$$\overbrace{\frac{p_s}{\lambda_s}\left(\left(1-\sigma_{ss}\right)\tilde{y}^s\left(p_s, p_h, \hat{k}\right) + \sigma_{sm}\tilde{y}^m\left(p_s, p_h, \hat{k}\right) + \sigma_{sc}\tilde{y}^c\left(p_s, p_h\right) + \sigma_{sh}\tilde{y}^h\left(p_s, p_h\right)\right)}^{=\tilde{\varepsilon}(\cdot)\hat{q}} -$$

$$\gamma_r P^r\left(p_s, p_h\right) - \gamma_d P^d\left(p_s, p_h\right)$$

Substituting for $\hat{y}_d$ from (21) into traditional farm level market clearing (15) yields

$$\tilde{\pi}^h_{p_h}(p_s,p_h))\widehat{H}_i - \tilde{c}^d_{p_h}(p_s,p_h))\tilde{y}^d\left(p_s,p_h,\hat{k}\right)=0 \tag{25}$$

From Euler (6), we have the steady-state condition

$$R\left(p_s,p_h\right)=\rho+\delta+\theta x \tag{26}$$

If a steady state exists, we find the root $\left(p_h^{ss},\, p_s^{ss},\hat{k}^{ss}\right)$ satisfying (24) and either (25) and (26). Knowing $\left(p_h^{ss},\, p_s^{ss},\hat{k}^{ss}\right)$, the remaining endogenous variables can be obtained using the reduced forms (19) and (21).

### 3.4.4 Differential equations

Our first differential eqution is (24). We need two additional equations. Define the traditional farm level market equation (15) as

$$\Pi^h\left(p_s,p_h,\hat{k}\right)\equiv\tilde{\pi}^h_{p_h}(p_s,p_h))\widehat{H}_i-\tilde{c}^d_{p_h}(p_s,p_h))\tilde{y}^d\left(p_s,p_h,\hat{k}\right)$$

and time differentiate

$$\Pi^h_{p_s}\left(p_s,p_h,\hat{k}\right)\dot{p}_s+\Pi^h_{p_h}\left(p_s,p_h,\hat{k}\right)\dot{p}_h+\Pi^h_{\hat{k}}\left(p_s,p_h,\hat{k}\right)\dot{\hat{k}}=0 \tag{27}$$

The second differential equation is obtained by time differentiating the home good equation (23). The result is expressed as

$$\tilde{\varepsilon}\left(p_m,p_s,p_h\right)q\left(\sum_{j=r,d,s}\lambda_j\frac{\dot{p}_j}{p_j}+\frac{\dot{q}}{q}\right)=\frac{1}{\lambda_s}\left(\dot{p}_s\bar{Y}^s\left(\cdot\right)+p_s\bar{Y}^s_{p_s}\left(\cdot\right)\dot{p}_s+p_h\bar{Y}^s_{p_s}\left(\cdot\right)\dot{p}_h+p_s\bar{Y}^s_k\left(\cdot\right)\dot{k}\right)$$

where

$$\begin{aligned}\frac{\dot{p}_r}{p_r} &= \frac{P^r_{p_s}\left(p_s,p_h\right)p_s}{P^r\left(p_s,p_h\right)}\frac{\dot{p}_s}{p_s}+\frac{P^r_{p_h}\left(p_s,p_h\right)p_h}{P^r\left(p_s,p_h\right)}\frac{\dot{p}_h}{p_h}\text{ and} \\ \frac{\dot{p}_d}{p_d} &= \frac{P^d_{p_s}\left(p_s,p_h\right)p_s}{P^d\left(p_s,p_h\right)}\frac{\dot{p}_s}{p_s}+\frac{P^d_{p_h}\left(p_s,p_h\right)p_h}{P^d\left(p_s,p_h\right)}\frac{\dot{p}_h}{p_h}\end{aligned} \tag{28}$$

Next, substitute the Euler equation (6) for $\dot{q}/q$ and simplify

$$\tilde{\varepsilon}\left(p_m, p_s, p_h\right) q \left( \frac{\theta - 1}{\theta} \sum_{j=r,d,s} \lambda_j \frac{\dot{p}_j}{p_j} + \frac{1}{\theta}\left(r^k - \delta - \rho - \theta x\right) \right) = \quad (29)$$

$$\frac{1}{\lambda_s}\left( \dot{p}_s \bar{Y}^s\left(\cdot\right) + p_s \bar{Y}^s_{p_s}\left(\cdot\right) \dot{p}_s + p_h \bar{Y}^s_{p_s}\left(\cdot\right) \dot{p}_h + p_s \bar{Y}^s_k\left(\cdot\right) \dot{k} \right)$$

We have three non-linear and autonomous differential equations (24), (27) and (29) in unknowns $\left\{\hat{k}, p_s, p_h\right\}$ that are linear in the dot variables $\left\{\dot{\hat{k}}, \dot{p}_s, \dot{p}_h\right\}$. We can use this system to obtain the three differential equations

$$\begin{aligned} \dot{\hat{k}} &= K\left(p_s, p_h, \hat{k}\right) \quad (30) \\ \dot{p}_s &= P^s\left(p_s, p_h, \hat{k}\right) \\ \dot{p}_h &= P^h\left(p_s, p_h, \hat{k}\right) \end{aligned}$$

# 4 Agricultural Land Market Integration

The purpose of this analysis is to evaluate returns to smallholder farmers from changes in the size of the smallholder and commercial farmland areas. The baseline model structures two separate land markets in which title transfers are very difficult to complete in terms of time and expenditure for smallholder farmers. Effectively, the two land markets are not integrated. This separation reduces the opportunity for asset allocation for smallholders. Since only freehold land can be mortgaged, smallholders holding customary title have greater difficulty accessing credit facilities.

The analysis uses a one period adjustment to agricultural land market shares occurring in the beginning year, 1980. The model is subsequently solved going forward into future years. A comparison of results against the baseline model indicates how farming output and profits change with various degrees of market integration.

This exercise simulates the transfer of traditional lands to freehold title. The effect of this transfer is to reallocate a portion of smallholder land to the commercial farming sector. This reallocation does not imply that smallholders lose control or possession of their land. Rather, smallholders retain

ownership and rights to profits, but now operate with commercial farming technologies and access to modern food retail markets.

The magnitude of adjustment for this land integration analysis is based on historical estimates. In order to better understand the long-term impact of changes in land shares, we increase the magnitude of the simulated changes in land area, finding that the trends are similar to those of smaller magnitudes in line with historical estimates. Thus, we settle on a 25% change in smallholder land area.

Among other measures of profit, farm profit per hectare provides insight into the productivity of farmland. Determining farm area is more difficult for Zambia due to data limitations. Type of land title can give an idea of the relative size of the farming sectors. By this measure, 93% of land is customary title and 7% is freehold title. However, Siegel (2008) finds that only about half of the freehold titled land is used in agriculture. Table 10.1 describes Zambia's usage of land.

Although Zambia's agricultural area, which includes arable land and pastures, is 21.4 million ha, only 2.9 million ha is arable land, about 13%. Additionally, although 47.9 million ha are classified as traditional lands, only 2.9 million is arable. Based on title, 92.8% is customary land and only 3.6% is freehold commercial farmland. Allocation of arable land according to the above shares implies that traditional farms account for 2,666,990 ha and commercial farms 103,005 ha.

Siegel (2008) uses survey data to create a distribution of farms by size categories. Small-scale producers are the most numerous at about 800,000. Their average farm size is just over 3 ha. Emergent farmers average about 12.5 ha. Large-scale commercial and corporate farms make up the commercial farm sector, which is very small in terms of number of operations and total area. Aggregated totals give an average smallholder farm size of 3.58 ha, constituting a 0.957 share of arable land, 3,041,995 ha. The commercial farm share is 0.0431 representing 137,005 ha. The profit per hectare equation uses these totals.

From the baseline model, per hectare profits for commercial farms are 153,155 ZKW in 1995, about 5.9 times as great as smallholder per hectare profits. By the 55th period, in 2035, commercial farm per hectare profit rises to 329,376 ZKW and the ratio falls to about 4.1. Over time, per hectare profits continue to increase with smallholder farms slowly approaching commercial farm profits.

Table 4.1: Zambia Land Use Summary, 1994

| | Hectares | |
|---|---|---|
| Surface Area | 75,261,000 | |
| Land Area | 74,339,000 | |
| Agricultural Area | 21,473,000 | |
| Arable Land and Permanent Crops | 2,873,000 | |
| Arable / Agricultural Land | 0.1338 | |
| Arable / Land Area | 0.0386 | |
| | | |
| Land by Title | Hectares | |
| Land with Title Deeds | 3,700,000 | |
| Traditional Lands | 47,900,000 | |
| Total | 51,600,000 | |
| | | |
| Share based on Title | Share | |
| Traditional (customary title) Land Share | 0.928 | |
| Freehold title land share (non farming land) | 0.036 | |
| Freehold title - commercial farming share | 0.036 | |
| source: Seigel (2005) | | |
| | | |
| Allocation of Arable Land | Hectares | Share |
| Traditional Farm Share of Arable Land | 2,666,990 | 0.963 |
| Commercial Farm Share of Arable Land (about 0.036) | 103,005 | 0.037 |
| Total Arable Land | 2,769,995 | 1.000 |
| source: WDI | | |

Table 4.2: Distribution of Farm Area in Zambia

| | Approximate N. of Producers | Approximate Farm Size (ha) | Total Area (ha) | Share of Area |
|---|---|---|---|---|
| Small-scale producers | 800,000 | 3.05 | 2,440,000 | 0.737 |
| Emergent Farmers | 50,000 | 12.50 | 625,000 | 0.189 |
| Large-scale Commercial Farms | 700 | 100.00 | 70,000 | 0.021 |
| Large corporate operations | 22 | 8,000.00 | 176,000 | 0.053 |
| Total | 850,722 | | 3,311,000 | 1.000 |
| | | | | |
| Aggregated Totals (adjusted to agree with title deed estimate) | | | | |
| Smallholder Farms | 850,000 | 3.58 | 3,041,995 | 0.919 |
| Commercial Farms | | | 269,005 | 0.081 |
| Total Farm Area | | | 3,311,000 | 1.000 |

source: Seigel (2005)

## 4.1 Conversion of 25% of Smallholder Farmland to Commercial Farms

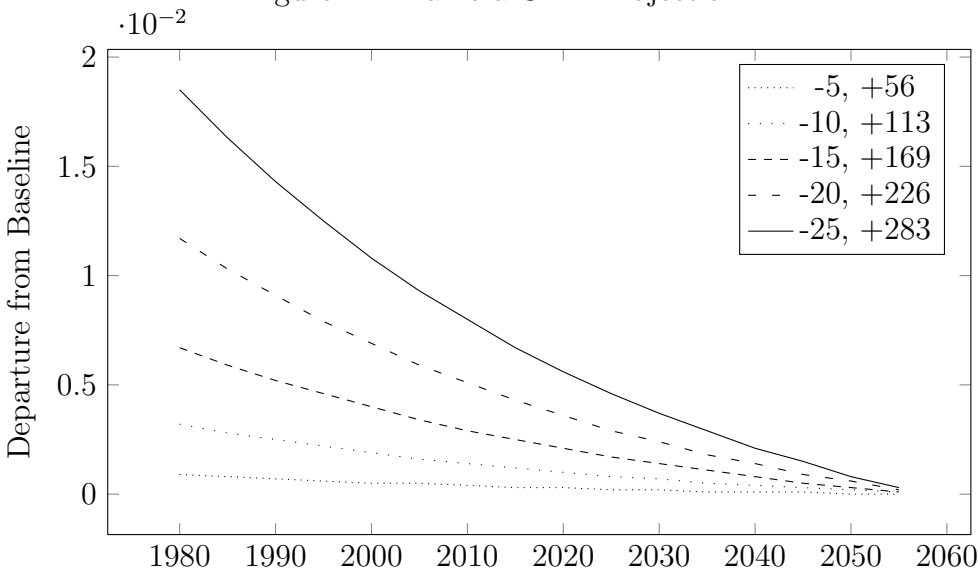
This analysis, which represents a one-time shift in the distribution of farmland between customary and freehold tenure, compares the alternative scenario to the baseline as a normalized departure from the baseline in percent terms. Because this shift is a one-time event, model results generally show immediate adjustments followed by convergence toward the long-term baseline values. Moreover, since the following charts show the difference between the analysis and baseline, it is not apparent which statistic is changing. Movement of the difference is relative to the state of the two measures.

The conversion of 25% of existing smallholder, customary tenure agricultural land (about 760,499 ha) to commercial, freehold title status, amounts to a 282.7% increase in commercial land area. The essence of this conversion is the reclassification of 25% of smallholder lands to the commercial farming sector. Smallholders retain ownership of this land and continue to earn profits and land rents from it. Significantly, this newly converted land now employs more capital-intensive production technologies. The output of this land may now be marketed to modern retail food channels or exported. The objective is to observe the impact of such a conversion on the structure of the economy and thus understand the benefits of land market integration. Although the decline in customary land is 25%, the percentage increase in freehold title

land is more than eleven times greater because the commercial farming sector is proportionately much smaller. The conversion of land tenure also adjusts the share of technology between customary and freehold lands, which in turn affects the productivity of land. However, land share is the only factor adjusted in this exogenous fashion. The model adjusts complementary supplies of labor and capital through the factor market equations. In the following charts, the orange line represents this simulation. The (25) means a 25% decrease in customary tenure land and the 283 means a corresponding 283% increase in freehold tenure farmland.

Starting with economy-wide effects in figure 4.1, we observe that Zambian GDP initially increases by about 1.8% compared to the baseline. This effect dissipates overtime as simulation model converges with the steady state.

Figure 4.1: Zambia GDP Projection




In figures 4.2-4.5 below, decomposition of GDP into income by source reveals that labor and smallholder farms capture most of this increase while capital rents fall. Commercial farm income also rises just over 200% on a 283% increase in land area. Commercial farm profit shows persistence in contrast to smallholder profit. With reduced land area, smallholder income actually increases at a rate of about 2.2% due to a combination of higher prices received and more productivity. As we will see later, capital rents fall mainly from a related fall in industrial production.

Figure 4.2: GDP by Income: Capital Rent

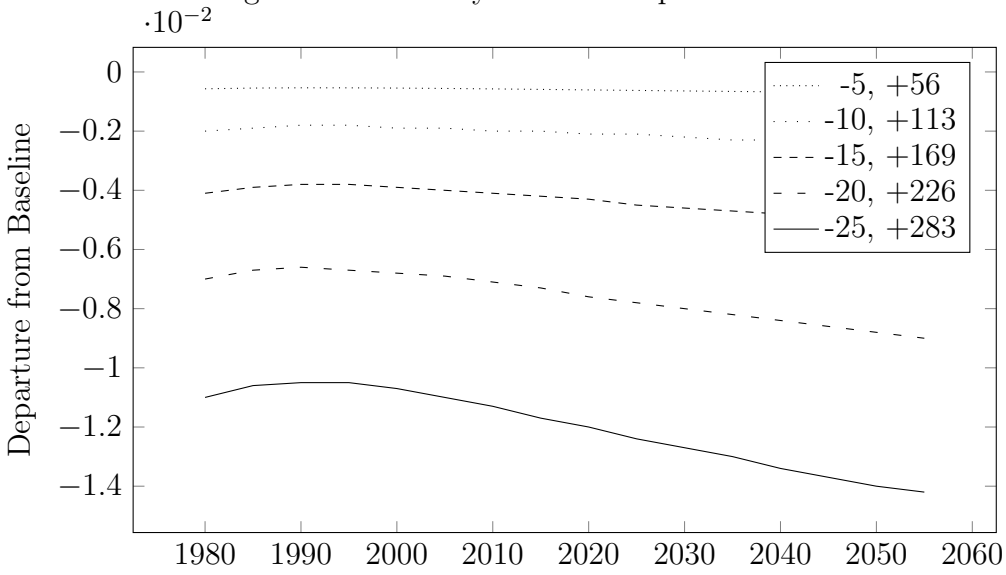
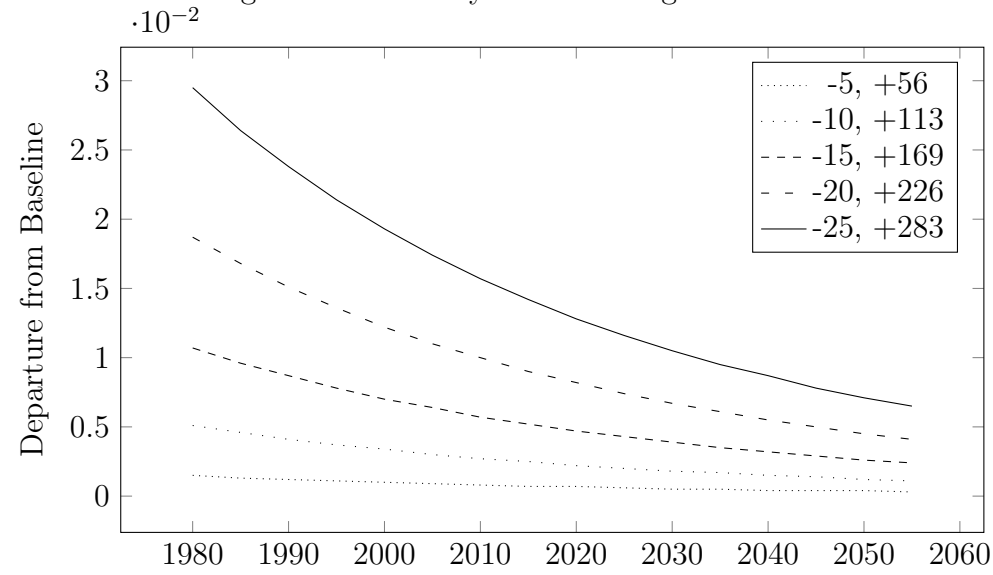



Figure 4.3: GDP by Income: Wage Income




In figures 4.6-4.10, a decomposition of GDP by expenditure shows that the representative household spends a larger share of income on food of both types, and services, while industrial goods and savings shares fall. The reason

Figure 4.4: GDP by Income: Smallholder Farm Profit

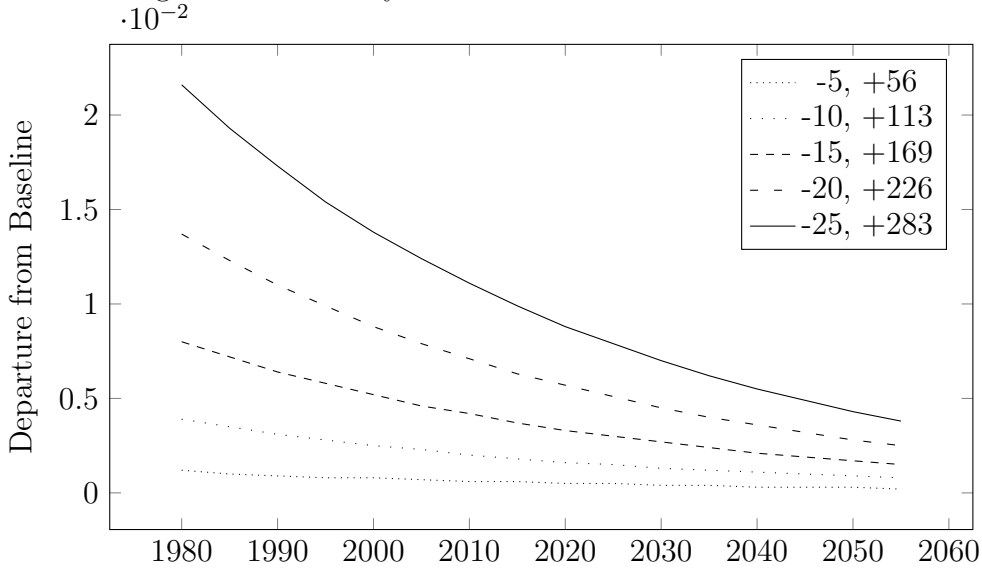
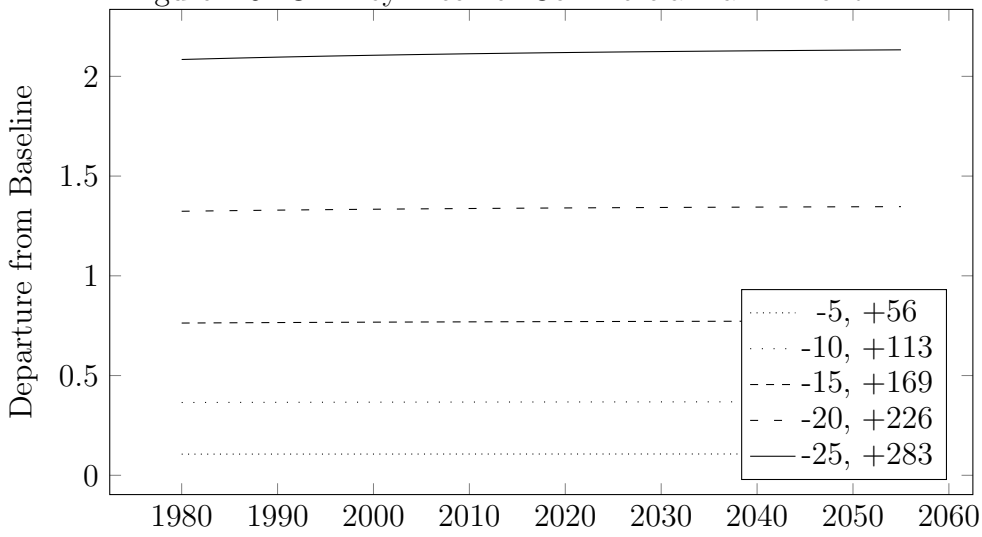



Figure 4.5: GDP by Income: Commercial Farm Profit

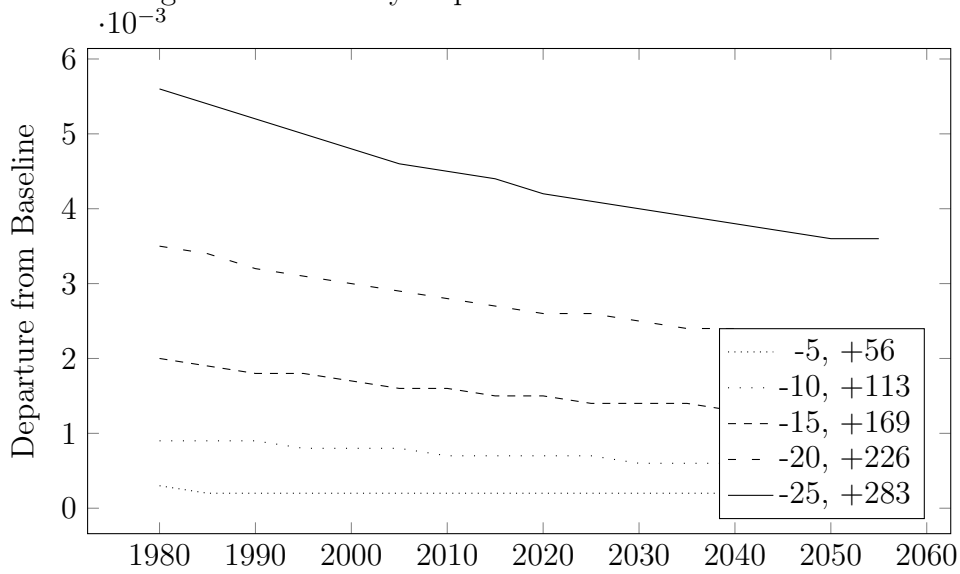



for rising food expenditures is specific to the sector. In the case of traditional food, the positive variance from baseline of about 0.55% is due to higher prices in an inelastic demand environment. Alternatively, the 0.7% increase in modern food expenditures is attributed to higher production volumes.

Service expenditures also increase, perhaps due to a lower price of labor resulting from falling smallholder output.

Industrial goods, however, register the largest change in expenditures. Specifically, in the modeled economy, international trade in industrial goods and the commercial farm intermediate good must balance. In this analysis, commercial farm production increases with the surplus exported to the rest of the world. This expansion of commercial farm exports, by definition, calls for an offsetting increase in industrial good imports. At the same time, consumption of industrial final goods rises against the baseline. Together, these effects make excess demand for industrial goods even more negative. Moreover, savings expenditures also fall, but with increasing magnitudes. By the time the half-life to the steady state is reached, saving expenditures are running about 1.4% below the baseline. The expenditure story suggests that households compensate for increased expenditures for food and industrial goods by trimming back on residual savings while depending on increased imports to satisfy their industrial demands.

Figure 4.6: GDP by Expenditure: Traditional Food




In figure 4.11, the drop in the ratio of savings to GDP confirms the change in expenditures. The ratio initially falls 2.0% from the baseline. In addition, in figure 4.12, the decrease in the savings/GDP ratio appears to only slowly revert to the long-run growth, baseline growth path.

Figure 4.7: GDP by Expenditure: Modern Food

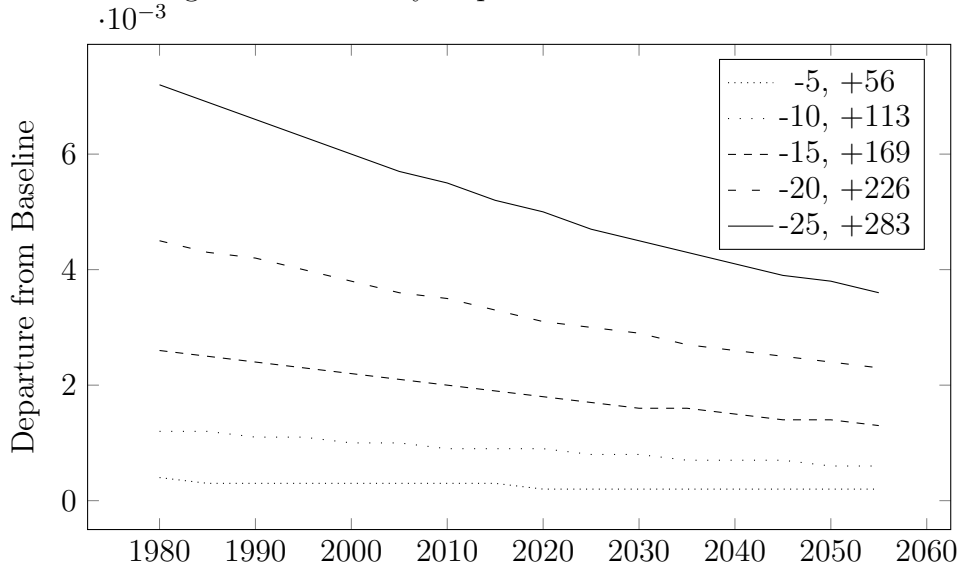
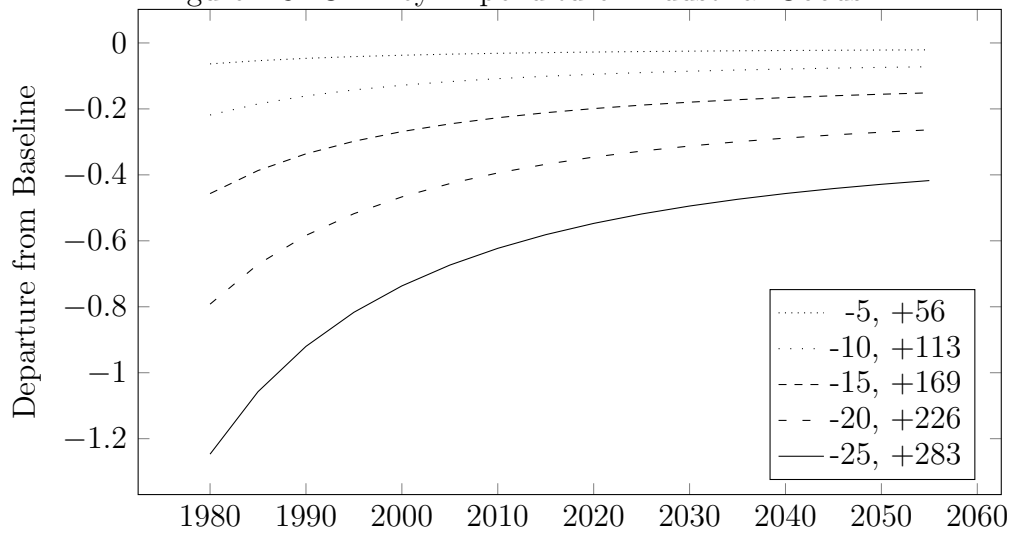



Figure 4.8: GDP by Expenditure: Industrial Goods




In contrast to the savings/GDP ratio, the capital/GDP index rises at a sustaining rate, reflecting the increased deployment of capital in the farming sectors. The increase, though, only shows a 0.6% increase from the baseline at the half-life to the steady-state. Although industrial production falls,

Figure 4.9: GDP by Expenditure: Services

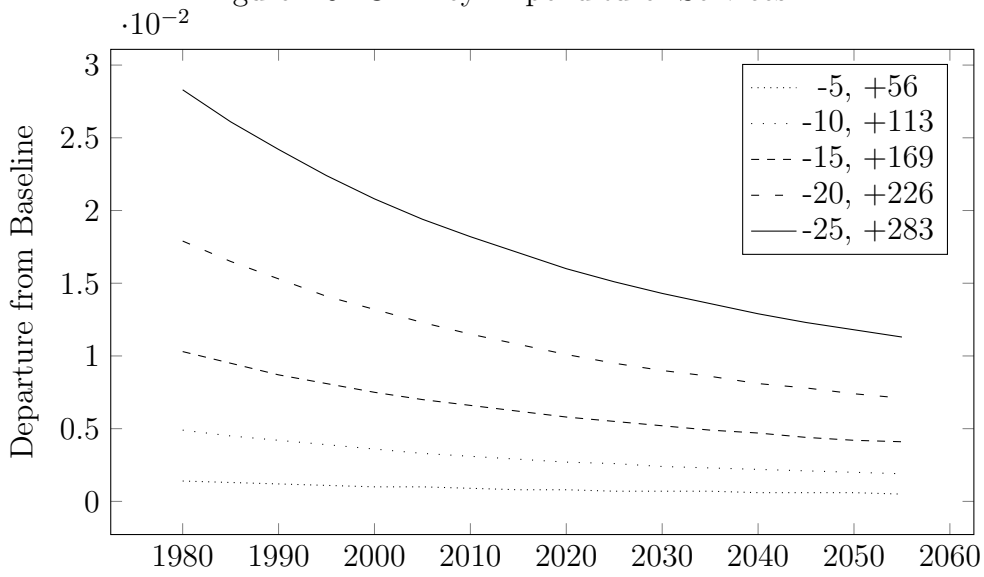
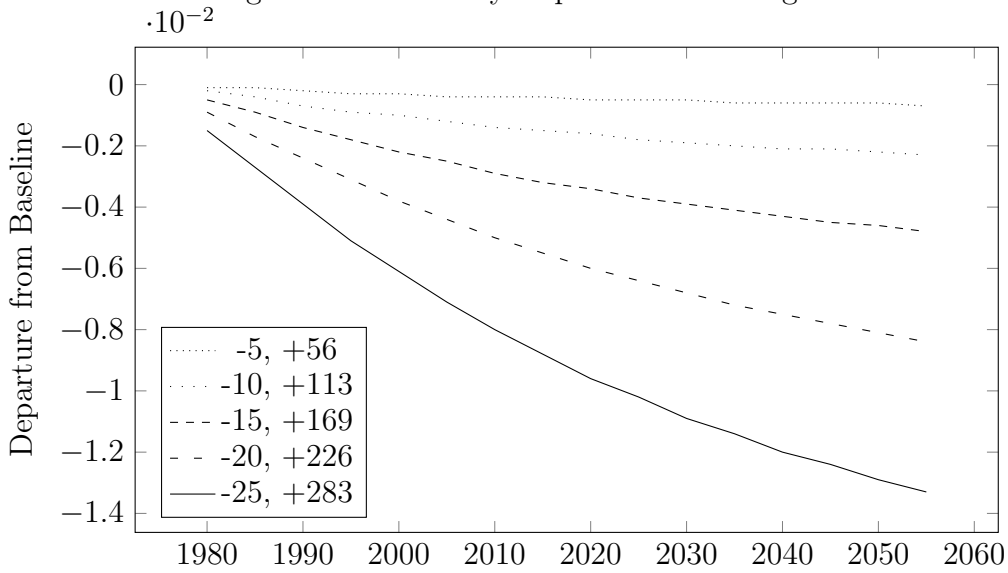



Figure 4.10: GDP by Expenditure: Saving




commercial farming manages to use more capital, thus generating a slight net increase in the ratio.

In figure 4.13, the alternative model predicts that prices will increase

Figure 4.11: Ratio of Savings to GDP

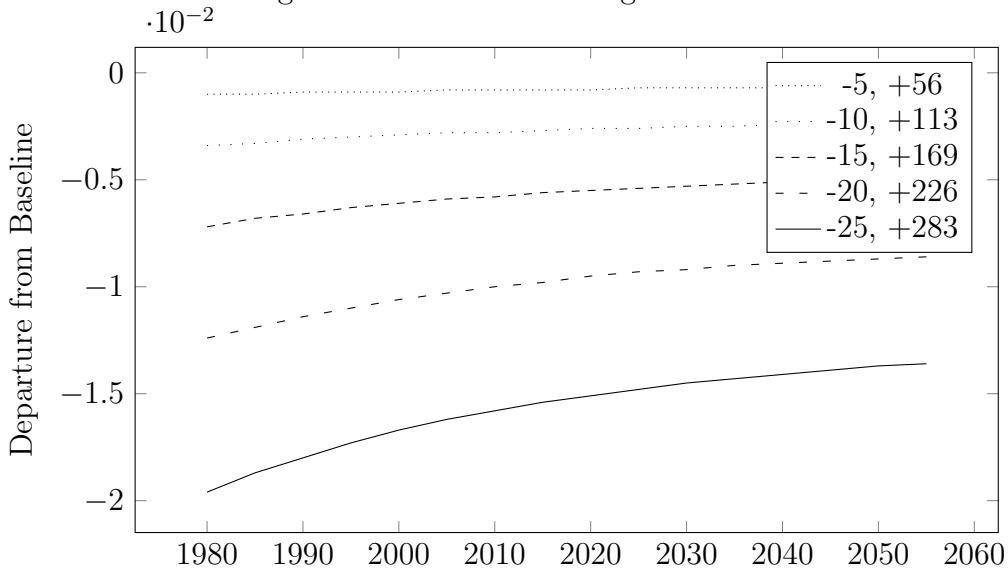
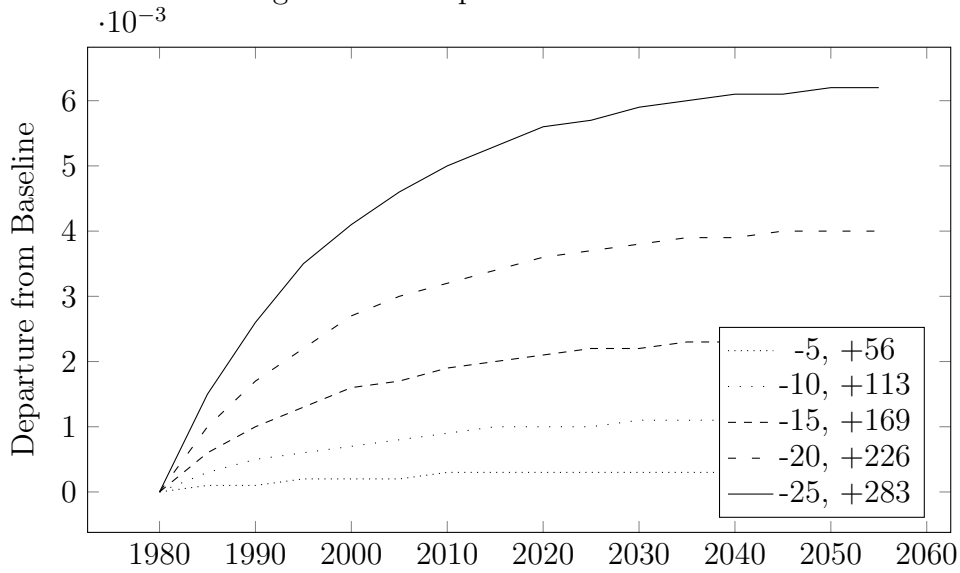


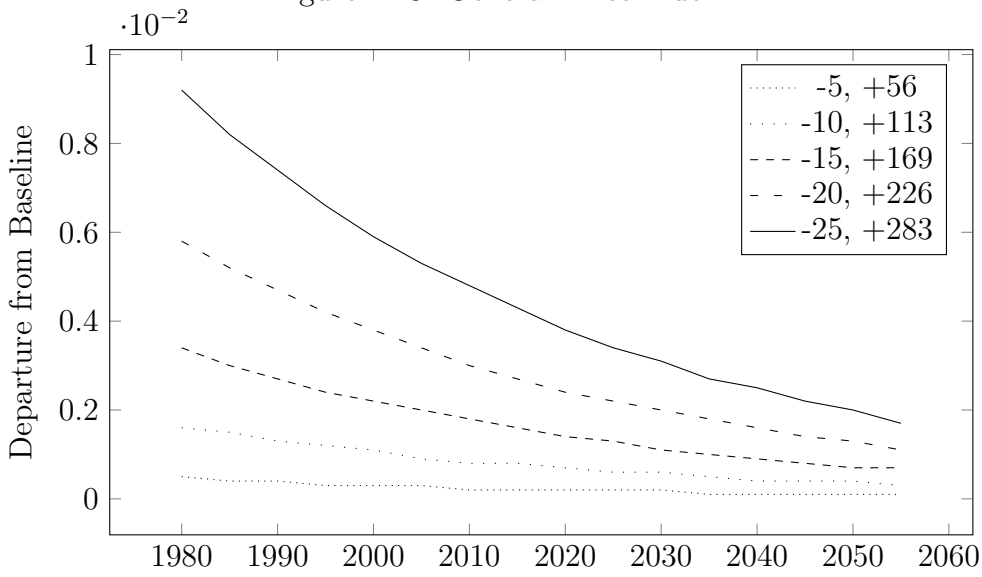

Figure 4.12: Capital to GDP Index




against the baseline with an initial jump of 0.9%, reflecting the increased demand for resources resulting from the simulated transfer of land. The details by sector reveal that all prices increase against the numeraire, industrial

goods.

Figure 4.13: General Price Index




In response to the transfer of farmland, the cost of labor rises almost 3.0% (figure 4.14) and the return to capital falls about 1.1% (figure 4.15), relative to the baseline. This result implies that the marginal productivity of labor in Zambia increases. The reduction in smallholder farmland has a proportionately smaller effect on its labor force. In addition, the shrinking industrial sector has a relatively small effect on the labor market. Although commercial farming output grows, the effect on labor is relatively small because its technology is more capital intensive than smallholder farming. The largest positive factor for labor demand appears to originate in the growth of the labor-intensive services sector.

It is interesting to note that the rise in labor cost is more than double that of capital, suggesting that labor faces a greater shock than capital. This contrast would imply that labor becomes relatively more scarce compared to capital.

In figure 4.16, smallholder farm-gate prices initially jump 1.6% while commercial farm-gate prices (figure 4.17) rise only 0.44%. This variance may be explained by increased supplies due to more cultivated land. The question of why all prices rise may be approached by considering the influence of relative factor prices. The increase in land allows the commercial farming sector to

Figure 4.14: Labor Cost per Worker

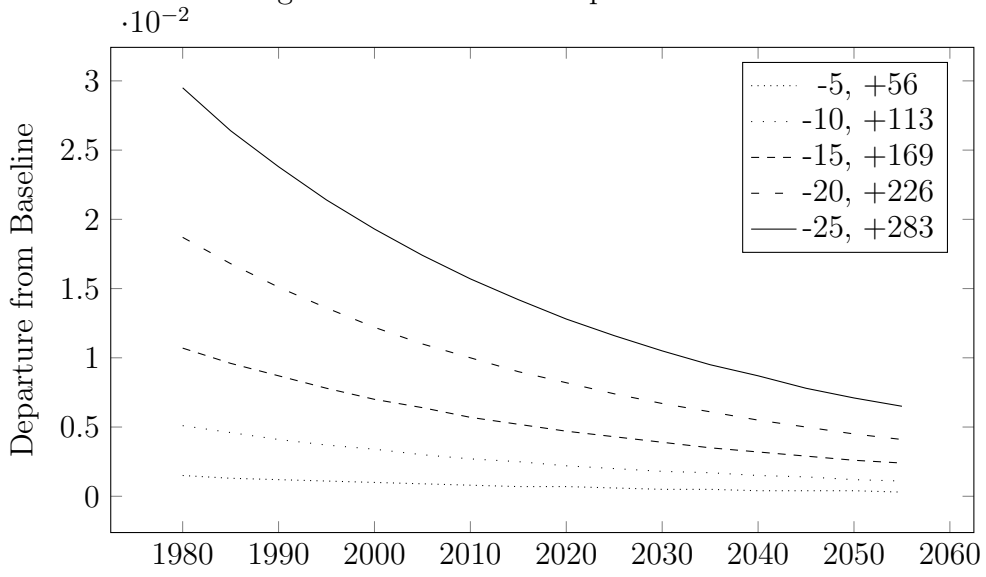
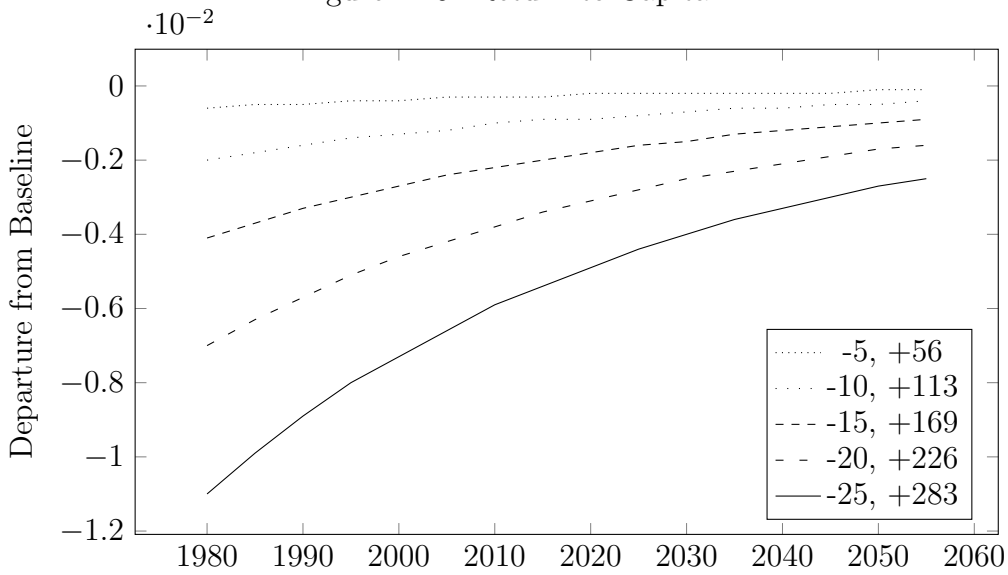



Figure 4.15: Return to Capital

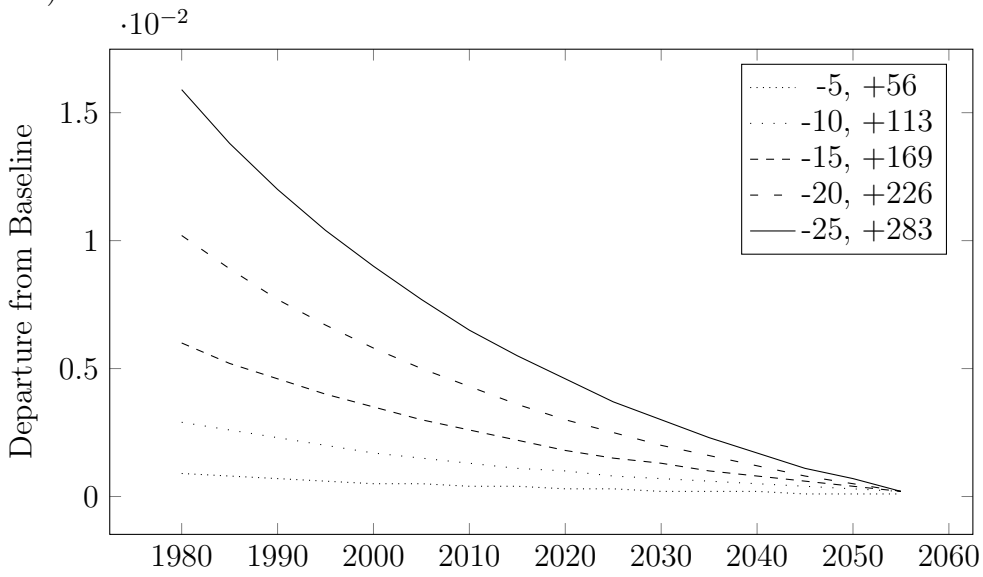



expand, increasing complementary demand for capital and labor, while the smallholder sector releases more labor than capital. This increased demand for capital increases capital rental income to households and simultaneously

raises the cost of capital, the intensive factor of industry. The new demand for capital also places pressure on the labor market, as the modern food retail channel can afford to pay higher wages. The result, a higher maket clearing wage, places pressure on the labor-intensive services sector, forcing it to raise prices to cover higher labor costs.

In figure 4.18, traditional retail food prices also initially jump 1.6% while modern retail food (figure 4.19) only rises 0.44%. This variance may be explained by increased supplies due to more cultivated land. Similarly, the traditional channel supply is now constrained, resulting in a higher price increase.

Figure 4.16: Price of Smallholder Agr. Good (Traditional Retail Equivalent Price)




Simulated farm output rises for both sectors compared to the baseline. Smallholder farm output unexpectedly rises a modest 1.3% against baseline results. With 25% less smallholder farm area, one would expect output to fall. This result suggests, as described below, that smallholders respond to the reduced land holdings and higher farm gate prices by shifting to more capital-intensive production.

Commercial farming output rises almost 3.0% above the baseline based on a 283% gain in land holdings. The weak response in commercial farm

Figure 4.17: Price of Commercial Agr. Good (Modern Retail Equivalent Price)

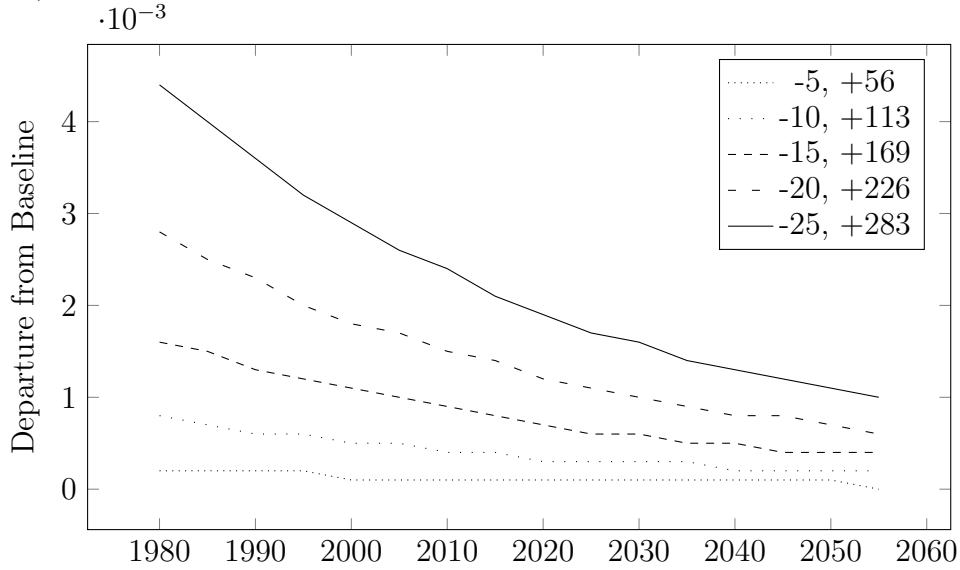
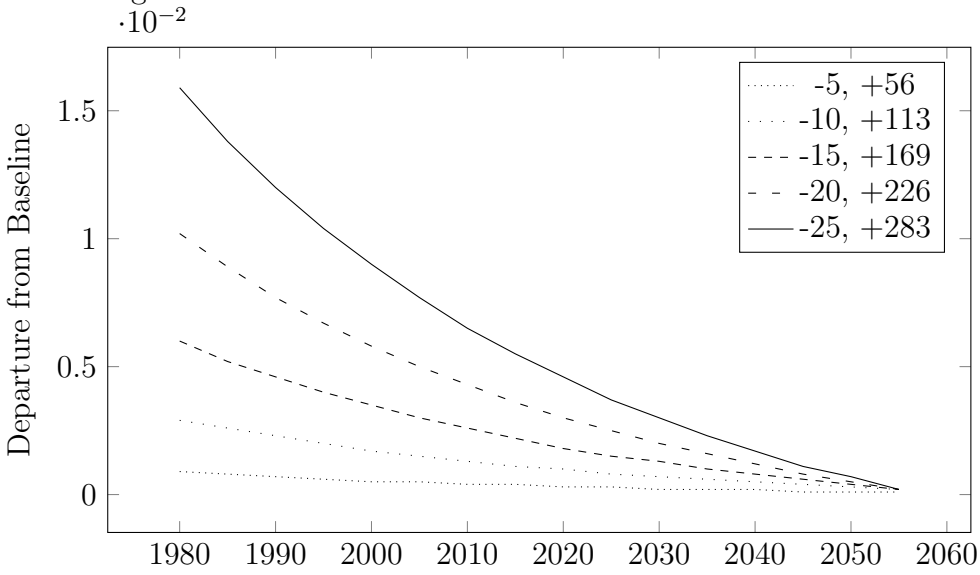
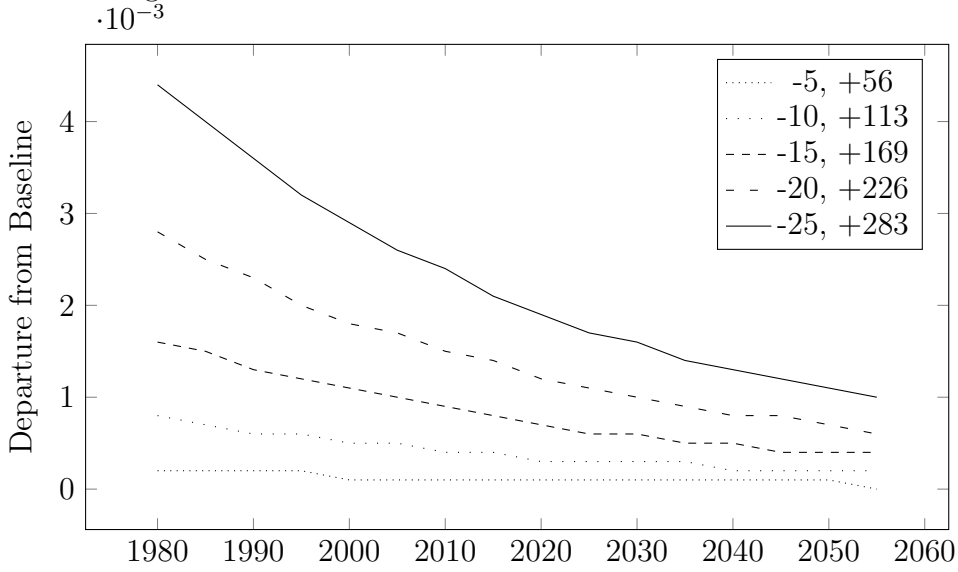



Figure 4.18: Price of Traditional Food Retail Final Good




output reflects lands relatively small degree of factor productivity compared to labor and capital.

Figure 4.19: Price of Modern Food Retail Final Good




Farm profit per hectare sums up the effects of transitioning a quarter of smallholder farmland to the commercial farming sector. Not surprisingly, in figure 4.20 smallholder profit per hectare rises about 36% compared to the baseline result. The obvious factor is the reduction in farmland area, the denominator of this statistic. In addition, another factor, probably higher farm gate prices, causes profit per hectare to increase an additional 11%.

As for commercial farms, profit per hectare displays an interesting U-shaped pattern. In figure 4.21, as additional amounts of land are transferred from the smallholder sector, profits per hectare first fall by 35% and then recover to a decrease of about 20% compared to the baseline. This trend suggests that two opposing factors are at work. Commercial farm profit is the only statistic to display such a reversing trend. On the one hand, as land area increases, profit per hectare falls. On the other hand, commercial farming experiences a scale advantage which begins to outweigh the land area effect starting after a 113% increase in land area.

Another interesting feature of both farm profit trends is their remarkable stability in the projection. While the alternative output (see next paragraph below) drifts back toward the baseline, both farming sectors protect their profit margins. This suggests that the alternative allocation of farmland is superior to the constrained, baseline allocation.

Figure 4.20: Smallholder Farm Profit per Hectare

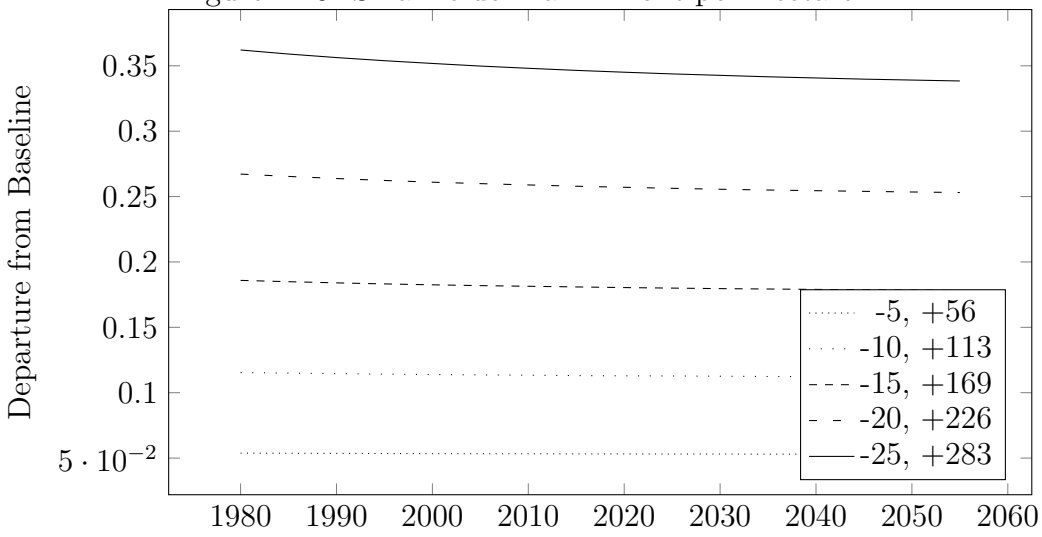
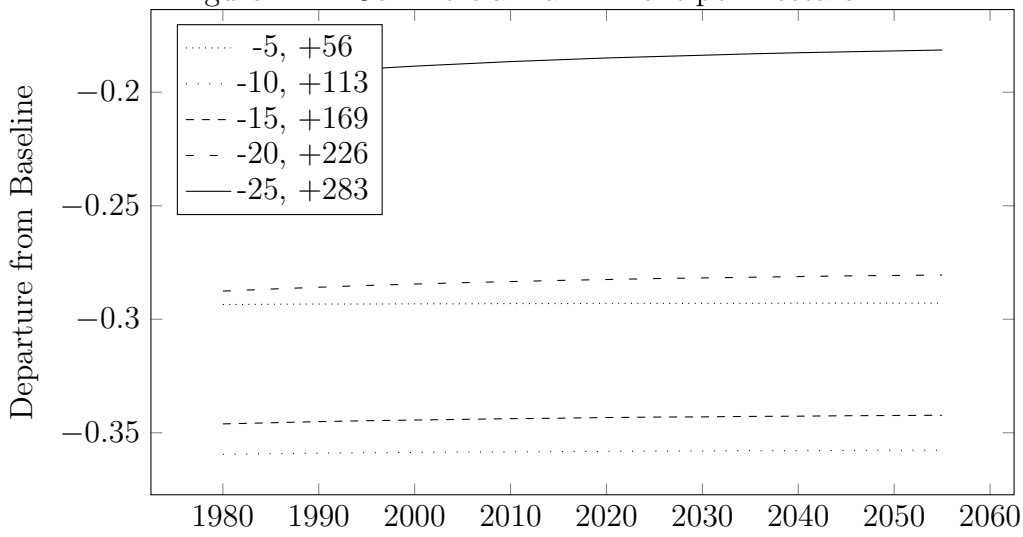


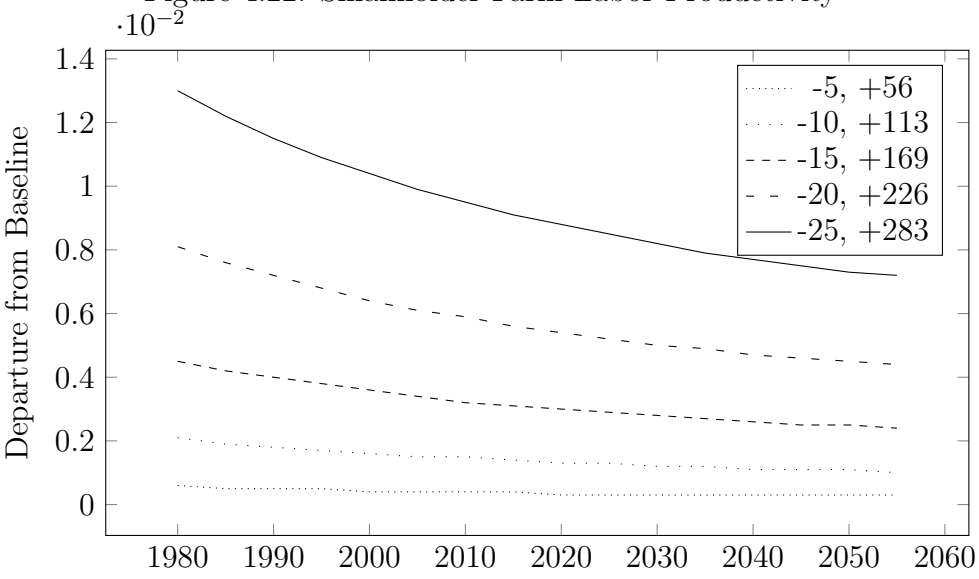

Figure 4.21: Commercial Farm Profit per Hectare




Farm labor productivity also rises with output for both sectors. In figure 4.22, smallholder farmers become about 1.35% more productive compared to the baseline while commercial farmers (figure 4.23) are about 3.0% more productive. The rise in labor productivity indicates the presence of capital deepening. As the industrial sector scales back output, industrial demand

for capital falls. As the rental rate of capital falls, its lower relative price increases the demand of the two farming sectors. The shift in land resources and related relative factor prices leads smallholder farmers to employ more capital in intensive production. Commercial farmers, on the other hand, increase demand for capital as they put newly acquired land into extensive production.

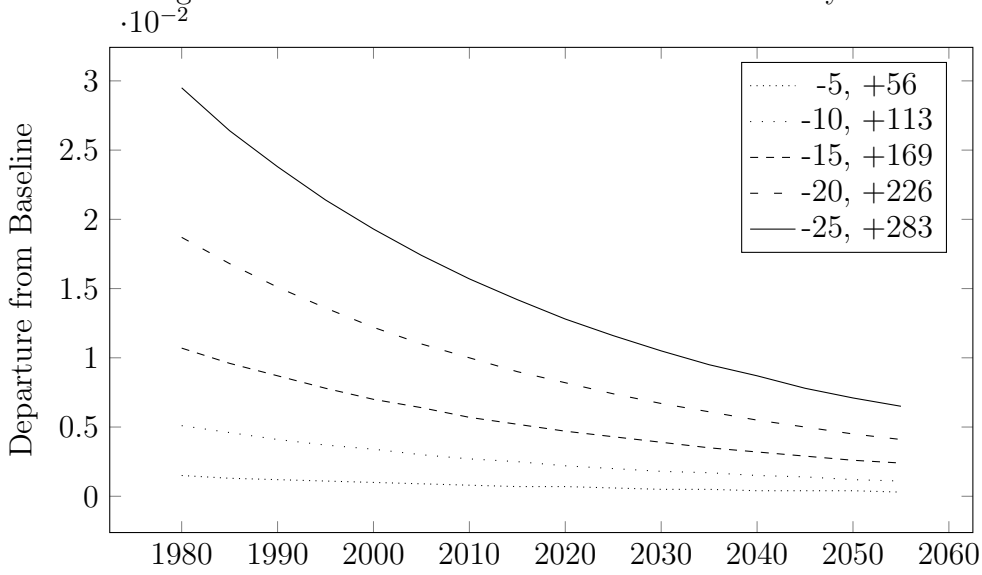
Figure 4.22: Smallholder Farm Labor Productivity




In figures 4.24 and 4.25, agricultural labor shares show the impact of the simulated transfer of smallholder land to the commercial farming sector. Relative to the proportion of land converted, the share of smallholder labor following to the commercial sector is less than 1.0% compared to the baseline. On the commercial farming side, labor share increases from the baseline a sustained 200%. Note that compared to the baseline, much of the loss in the smallholder labor share is made up over the course of the projection. However, the increase in commercial farming workforce numbers is sustained, meaning that commercial farming can continue to profitably employ these workers with its current technology.

The loss in the labor-intensive smallholder labor share is relatively small, revealing just how large the smallholder farming sector is. The more capital-intensive commercial farming sector experiences a relatively large inflow of labor. This result shows the relatively weak effect of land as a factor of

Figure 4.23: Commercial Farm Labor Productivity




production. Since the relative factor intensity of land is relatively small compared to labor and capital, the effect of marginal changes in the quantity of land is subdued. Also, the dissipating fall in smallholder labor share indicates that the sector is receiving most of the labor force growth. Commercial farming also receives a small proportion of the smallholder labor force growth.

## 4.2 Comparison of the Land Conversion Case with the Baseline

The purpose of the alternative case is to evaluate returns to smallholder farmers from limited integration of smallholder and commercial farmland areas. The extended purpose of this analysis is to understand the impact of these changes on the structure of the Zambian economy. In this analysis, 25% of Zambia's smallholder sector land is converted to the commercial farming sector. This 25% exchange of smallholder land is effectively a change in agricultural sectors where smallholder farmers continue to own their farms. Commercial farming technology now replaces former smallholder technology, along with associated revenues and expenses.

A general observation of this exercise is that changes in factor endowments, such as in this case of agricultural land, generate economy-wide ef-

Figure 4.24: Labor Share - Smallholder Agriculture

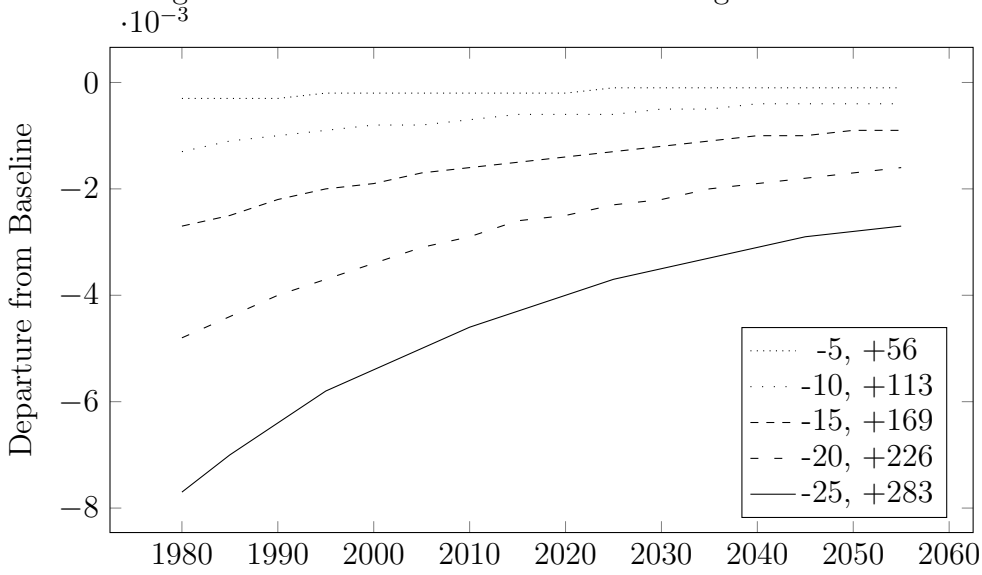
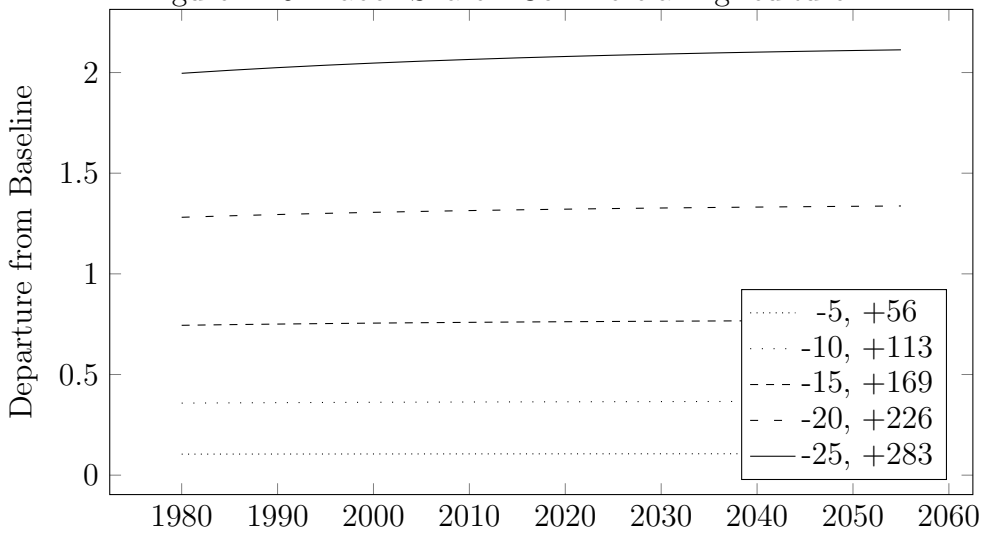



Figure 4.25: Labor Share - Commercial Agriculture




fects all along the production and marketing chain. Since factor endowments help shape the nature of production from the earliest stages until final consumption, they have a strong influence in the design of production chains and marketing channels.

A second observation is that as the alternative and baseline models advance in time, most, but not all indicators converge with most gains and losses from the one-time change in land endowments dissipating. In the long-run, both the alternative and the baseline trend toward the steady-state, albeit from different starting points. However, it is not readily apparent which modelbaseline or alternativeadjusts to make up the difference.

In summary, table 4.3 lists the dominant value for each departure statistic of the analysis. Next to each value is a description of the values trend (up or down) and whether it is converging or diverging in relation to the baseline trend. A - indicates if a trend tapers off in the future. A - - indicates a relatively flat trend.

A comparison of statistics highlights major departures from the baseline. In the first section, GDP by income shows the expense paid by capital income in exchange for the advance of the other sectors. Overall, GDP advances about 1.8% with differences to baseline dissipating. Important for this study, smallholder farm profit advances 2.2% while commercial farm profit surges 208%.

For final goods expenditures, modern food advances a small 0.7% while traditional food is slightly behind. Services advance the most at 2.8%, most likely a result of higher incomes. Expenditures on industrial goods dropped, a result of the function of the balanced trade assumption in the model. As commercial agriculture exports increased, imports of the other traded good, industrial goods, rise to automatically balance trade. This adjustment resulted in the simultaneous effects of slashing domestic production and stimulating consumption of imported goods.

The ratio of Savings/GDP and the index of capital/GDP show a one-time reduction of savings and a small rise in the capital stock relative to GDP. The two statistics almost appear to offset one another. The fall in Savings/GDP is slowly made up over time, but the capital/GDP ratio slowly diverges, reaching 0.6% towards the half-life of the projection. Savings and capital accumulation appear to take a negative shock from which they slowly recover over 50 years.

Prices tell a story of an immediate shock that diminishes over time. The general price index rises 0.9% against the baseline. Labor and capital factor prices each experience similar shocks reflecting the relatively more scarce labor supply. The price of the smallholder agricultural good rises 1.6% while the commercial agricultural good rises only 0.4%. Following the marketing channel, the price rise for the retail traditional good is 1.6%. Modern food

prices remain more stable, about 1.2% behind traditional food prices. This result shows that price transmission appears to exist along the traditional marketing channel, although the direction of causation is not evident.

In a surprising result, smallholder output advances 1.3% against the baseline in spite of losing 25% of its land endowment while commercial farming output grows by 3.0%.

Further down the marketing channels, retail supplies roughly follow their intermediate goods producers. Note that commercial farm output rises 2.9% while modern retail supply increases only 0.7%, which allows for increased exports. Smallholder output rises 1.3%, slightly higher than traditional retail expenditure, which rises only 0.6%, for an unknown reason, perhaps relating to Stone-Geary preferences. In the modeled economy, traditional retail purchases all the smallholder output.

Profits per hectare clearly reflect the adjustment in land endowments. Commercial profits per hectare fall 19.4% on the increase in agricultural land area. Smallholder profits are more robust than commercial profits, losing proportionately less land than commercial farming gains, but registering a larger magnitude growth in profit per hectare, 36.0% versus (19.4%). The trend in smallholder profits is more stable than the U-shaped pattern of commercial profits. Smallholder farm profit, reviewed above, provides a complete picture of profitability, including volume and price effects.

Labor productivity on commercial farms increases 2.9% versus only 1.3% for smallholder farms. Under the alternative case, smallholders now have less farmland over which to apply capital and labor. However, the percentage loss in the smallholder labor force is relatively small compared to the large labor gains for commercial farming. In addition, some smallholder labor migrates to the commercial farming sector, reducing smallholder labor supply.

Across both sectors the increase in capital per farm worker remains stable at 4.1% compared to the baseline, indicating the presence of capital deepening. As capital deepening is a ratio of capital to labor, changes to either or both factors may affect it. This result supports the idea of increasing labor productivity in the preceding paragraph. The smaller gains in smallholder labor productivity confirm the effect of differing starting points for capital intensity.

Table 4.3: Land Market Integration Analysis Summary Statistics

| Magnitude and Direction of Change from Baseline | | |
|---|---|---|
| **Chart** | **Departure** | **Trend** |
| GDP | 0.019 | converge ↓ |
| GDP-Income: Capital Rent | (0.011) | diverge ↓ |
| GDP-Income: Wage Income | 0.029 | converge ↓ |
| GDP-Income: Smallholder Farm Profit | 0.022 | converge ↓ |
| GDP-Income: Commercial Farm Profit | 2.084 | converge ↓ |
| GDP-Expenditure: Traditional Food | 0.006 | converge ↓ |
| GDP-Expenditure: Modern Food | 0.007 | converge ↓ |
| Capital/GDP Index | 0.006 | diverge ↑ - |
| Labor Cost/Worker | 0.029 | converge ↓ |
| Return to Capital | (0.011) | diverge ↑ |
| Price of Smallholder Good | 0.016 | converge ↓ |
| Price of Commercial Good | 0.004 | converge ↓ |
| Smallholder Farm Profit per Hectare | 0.362 | – |
| Commercial Farm Profit per Hectare | (0.194) | – |
| Smallholder Farm Labor Productivity | 0.013 | converge ↓ |
| Commercial Farm Labor Productivity | 0.029 | converge ↓ |
| GDP by Expenditure: Industrial Goods | (1.247) | converge ↑ |
| GDP by Expenditure: Services | 0.028 | converge ↓ |
| GDP by Expenditure: Saving | (0.001) | diverge ↓ |
| Savings/GDP Ratio | (0.020) | converge ↑ - |
| General Price Index | 0.009 | converge ↓ |
| Price of Traditional Retail Final Good | 0.016 | converge ↓ |
| Price of Modern Retail Good | 0.004 | converge ↓ |
| Price of Services | 0.013 | converge ↓ |
| Smallholder Output | 0.013 | converge ↓ |
| Commercial Output | 0.029 | converge ↓ |
| Supply: Traditional Retail | 0.006 | converge ↓ |
| Supply: Modern Retail | 0.007 | converge ↓ |
| Supply: Industry | (0.208) | converge ↑ |
| Supply: Services | 0.028 | converge ↓ |
| Capital per Smallholder Farm Worker | 0.041 | converge ↓ |
| Capital per Commercial Farm Worker | 0.041 | converge ↓ |
| Number of Smallholder Farm Workers | (0.008) | converge ↑ |
| Number of Commercial Farm Workers | 1.996 | – |
| Labor Share: Smallholder Farming | (0.008) | converge ↑ |
| Labor Share: Commercial Farming | 1.996 | – |
| Labor Share: Traditional Retail | (0.008) | converge ↑ |
| Labor Share: Modern Retail | (0.017) | converge ↑ |
| Capital Share: Traditional Retail | 0.033 | converge ↓ |
| Capital Share: Modern Retail | 0.023 | converge ↓ |

Notes: – = flat trend; - = trend tapers off

## 4.3 Land Market Integration Policy Discussion

In conclusion, the results of the land market integration analysis illustrate the interactive nature of the intermediate goods sectors and their factors. This analysis tells a story of Rybczynski like growth resulting from an increase in the endowment of commercial farmland. The expansion of commercial farmland increases derived demand for capital and labor, resulting in increased household income. Other sectors cannot afford to match the higher wages and release labor to commercial farming. In this modeled economy of balanced trade, increased commercial output and exports lead to higher imports of industrial goods, thus reducing demand for domestic industrial goods. Commercial farming experiences growth and profitability as it draws additional labor and capital resources into production.

These results highlight the importance of a sound institutional framework to the Zambian economy. In the context of the larger, national economy, factor markets benefit from clearly defined property rights and minimal transaction costs. These features have the additional benefit of enabling smallholders to participate in modern food marketing channels, if they so desire. One specific step to aid all smallholders is to strengthen and streamline the legal infrastructure serving farmers who desire to convert title of their land. While not all smallholders would be ready and desiring to convert title, those who desire should be able to do so with a reasonable expenditure of time and financial resources.

Moreover, the model allows for considerable freedom in the design and implementation of legal and trade policies, a task Zambians will have to work through. It is important to recognize that tradtional agriculture is composed of smallholders at different levels of technology and labor productivity. In light of this diversity, it is important to take the time to listen to the ideas of smallholder farmers at different levels of production and to take note of resources and endowments at their disposal. Thus, further research into the effectiveness of micro-level interventions would be beneficial, with the goal of discovering which approaches advance smallholders closer to participation in the modern marketing channel.

Third, the Government of Zambia should seek to create a policy environment that treats labor and capital mobility well, especially for smallholders. Recent advances in payment system technologies may be useful here. Also, efforts to improve the effectiveness of marketing channels–storage, contracts, aggregation, sorting, grading, etc.–would help too.

Lastly, these results show that simultaneous policies of targeting the poorest of the poor and encouraging emerging and commercial farming to thrive can be complementary objectives. A both/and approach would be more effective than an either/or approach. Since no one policy approach can serve all types of farmers, it would be useful to research what approaches are most effective in each case.

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