

Glauben, Thomas; Herzfeld, Thomas; Loy, Jens-Peter; Renner, Svetlana; Hockmann, Heinrich

Article — Accepted Manuscript (Postprint)

The impact of fiscal policies on agricultural household decisions

Economic Modelling

Provided in Cooperation with:

Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Halle (Saale)

Suggested Citation: Glauben, Thomas; Herzfeld, Thomas; Loy, Jens-Peter; Renner, Svetlana; Hockmann, Heinrich (2012) : The impact of fiscal policies on agricultural household decisions, Economic Modelling, ISSN 1873-6122, Elsevier, Amsterdam, Vol. 29, Iss. 2, pp. 166-177, <https://doi.org/10.1016/j.econmod.2011.09.010> , <https://www.sciencedirect.com/science/article/pii/S0264999311002288>

This Version is available at:

<https://hdl.handle.net/10419/271539>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by-nc-nd/4.0/>

The Impact of Fiscal Policies on Agricultural Household Decisions

Thomas Glauben ^a, Thomas Herzfeld ^{a,b}, Jens-Peter Loy ^c, Swetlana Renner ^a, Heinrich Hockmann ^a

^a Leibniz-Institute of Agricultural Development in Central and Eastern Europe, D-06120 Halle/Saale, Germany

^b Wageningen University and Research Centrum, Department of Social Sciences, NL-6706KN Wageningen, The Netherlands

^c Department of Agricultural Economics, University of Kiel, D-24098 Kiel, Germany

This is an accepted manuscript, which has been published in “Economic Modelling”.

Please cite this publication as follows:

Glauben, T., Herzfeld, T., Loy, J.-P., Renner, S., Hockmann, H. (2012). The impact of fiscal policies on agricultural household decisions. *Economic Modelling* 29 (2), 166-177.

You can download the published version at:

<https://doi.org/10.1016/j.econmod.2011.09.010>

Abstract

This paper provides a comparative static analysis of farm household's production, consumption, and labor market decisions under alternative tax policies. We explore the implications of non-separable household decisions caused by widespread non-participation in labor, land, financial and/or food markets, as is typical of low income economies. The analytical results indicate that when labor market imperfections occur, most tax-induced responses are ambiguous, mainly due to shadow price effects. This is particularly the case for the labor market and production responses to most tax tools under study, while a decreasing demand for consumption goods appears to be the result in several cases. Furthermore, tax-induced allocation effects may differ between the non-separable and the separable model versions, indicating the potential impact of labor market constraints on farm household responses to tax policies. In particular, standard taxes as well as a land tax may imply production adjustments in the case of non-separability.

Keywords: *Agricultural household model, non-separability, taxation*

JEL code: H20, H31, Q12

The Impact of Fiscal Policies on Agricultural Household Decisions

1. Introduction

Considering efficiency and redistribution aspects, there is a general consensus in the standard public finance literature that consumption taxes (particularly value added tax) and land tax are superior to agricultural taxes (output and input taxes, market surplus taxes) in developing countries (Newbery 1987; Burgess and Stern 1993; Khan 2001). However, there are at least two good reasons why taxation of household businesses in developing countries deserves special study and cannot simply be treated as a standard taxation problem of standard enterprises.

First, in many countries, especially in developing and transition economies, the use of both standard tax tools, value added and income taxes is limited. In contrast to industrialized countries, where income tax is the main source of tax revenues (more than 50%), income taxes constitute only less than one-third of the total tax revenues of developing countries and even less than 25% in transition countries (Gordon and Li 2005; Bahl 2006). Instead, indirect taxes (mostly value added tax, which mainly replaced taxes on foreign trade in last decades) play a major role among developing countries (more than 50% of tax revenues). It is often costly to tax transactions between producers and consumers by a value added tax, especially within the household or on informal markets. Furthermore, difficulties in observing a household's annual income restrict the implementation of a well-defined income tax scheme (Ahmad and Stern 1991; Newbery 1987). In many cases, small family farms are not obligated to keep records for quantity of produced and marketed outputs and for the costs of inputs. Furthermore, developing countries have a large informal sector which is excluded from taxation. It becomes apparent in the consumption of a substantial part of self-produced outputs; self-employment and other internal transfers excluded from market transactions. Most prominently, any value added tax (VAT) can be raised only on transactions in the formal sector possibly creating distortions between formal and informal sectors (Emran and Stiglitz, 2005). A major argument in favor of a land tax is a potential increase in land use efficiency and a greater equality. Furthermore, a land tax is seen as not creating production distortions (Newbery, 1987, Skinner, 1991). However, a land tax is difficult to implement due to a strong opposition and lobbying from the part of land owners and due to administrative problems (Khan, 2001; Skinner, 1991). A second difference relates to the implicit dichotomy of consumption and production decisions in conventional household and firm approaches. In particular, when related markets are imperfectly competitive, production organization and consumption choices are jointly determined (Strauss 1986).

There is an extensive literature on the identification of feasible taxation tools for peasant households ('agricultural taxes'). In this context, agricultural taxes are surrogates for standard taxes, in particular for income taxes. Prominent representatives include land taxes, output or input taxes, and poll taxes (Bird 1974; Rao 1989; Burgess and Stern 1993). In addition, some papers investigate the analysis of tax-induced allocation and distribution effects within partial equilibrium frameworks (Atkinson 1987) and dual-economy approaches (Sah and Stiglitz 1987), as well as the application of optimal taxation models to peasant economies (Heady and Mitra 1987; Stiglitz and Dasgupta 1971; Munk 1980). However, very few studies have focused on the rigorous derivation of farm household decisions to tax policies. Ahmad and Stern (1991) examine the farm household effects of several agricultural tax tools (marketed surplus, gross output, and input taxes) within a simplified theoretical farm household approach. Chambers and Lopez (1987) analyze the implications of standard taxes (income, profit, and consumption taxes) on financially constrained farm households within a dynamic approach. Lopez (1994)

considers several income tax brackets by the estimation of farm household decisions, but does not explicitly examine their implications on consumption and production decisions.

There are several reasons why labor markets may be imperfect, leading to non-separation of consumption, production and labor-supply decisions (Abdulai and Delgado 1999; de Janvry et al. 1991; Löfgren and Robinson 1999). For example, binding hour constraints in off-farm employment may prevent a complete adjustment in agricultural labor markets (Benjamin 1992). Family and hired labor may be imperfect substitutes in agricultural production (Deolalikar and Vijverberg 1987; Jacoby 1993). Also, farmers may have preferences towards working on or off the farm (Lopez 1994). In addition, costs associated with labor market transactions can explain why households have different relationships to the labor markets (Sadoulet, de Janvry and Benjamin 1996).

In this paper, we analyze the comparative statics of farm household decisions under both standard and agricultural taxes, assuming labor markets are imperfect. A non-separable model is developed to allow for imperfections on labor markets. The model implies increasing per-unit costs in accessing both the market for hired on-farm labor and the market for off-farm family labor (Carter and Yao 2002). Thus, the relevant wage rate is endogenously determined. The advantage of this approach is twofold. First, the model accounts for several kinds of labor market imperfections, notably institutional restrictions (e.g. binding hour constraints settled by collective agreements), variable transaction costs in accessing labor markets, or heterogeneity between hired and family labor on-farm and also between family labor on and off the farm (Low 1982, 1986). In particular, it differs from former approaches, which usually assume either a completely absent labor market or an exogenously fixed rationing of off-farm employment. Second, the approach is applicable to various labor market regimes, including the cases in which farms simultaneously hire on-farm labor and sell off-farm labor.

We investigate the comparative statics of the farm household to compare production, consumption, and labor market effects caused by alternative tax policies. In detail, we analyze an income and a value-added tax, the main standard tax tools, as well as an off-farm income tax ('wage tax') and several agricultural taxes (market surplus, input and land taxes). To control for tax-induced adjustments related to labor market imperfections, we compare the results to those derived from a separable approach assuming perfect labor markets. These comparisons allow us to examine basic rules regarding the optimality of the tax tools under consideration, at least from the efficiency point of view.¹ Since in a world of perfect markets standard taxes are superior to agricultural taxes and land taxes are superior to the other agricultural taxes, it is interesting whether this ranking pertains when labor markets are imperfect.

2. The Model

To concentrate on the role of tax policies and labor market constraints, we construct a static model that ignores some aspects of farmers' decisions, notably (price) risk (Finkelshtain and Chalfant 1991; Fafchamps 1992) and credit constraints (Chambers and Lopez 1987). The model

¹ In their seminal work, Diamond and Mirrlees (1971) argue that production efficiency is desirable within an optimal taxation system, even if a full Pareto optimum is not achieved. Thus, tax tools that do not violate production efficiency should to be preferred unless there are administrative limitations or special distributional reasons restricting their use.

framework can cover both the case of imperfect and, with few rearrangements, perfect labor markets.

We consider a representative household that owns a plot of land and produces market and home-consumed agricultural goods using variable inputs, labor and a land. The farm household is assumed to maximize utility (1) derived from the consumption and leisure subject to a technology constraint (2), time constraint (3), and a ‘tax corrected’ budget constraint.

$$(1) \quad \max_{\mathbf{c}, \mathbf{x}} U(\mathbf{c}) \quad \mathbf{c} = (C_a, C_m, C_l) \in R_+^n$$

subject to

$$(2) \quad G(\mathbf{x}, \mathbf{r}) = 0 \quad \mathbf{x} = (X_a, X_c, X_v, X_l) \in R_+^n \text{ and } \mathbf{r} = (R_G) \in R_+^n$$

$$(3) \quad T_l - |X_l| + X_l^h - X_l^s - C_l \geq 0$$

$$(4) \quad (1 + \tau_{vat})P_m C_m + P_a C_a \leq (1 - \tau_y) \left\{ (1 - \tau_{ms}) [P_c X_c + P_a (X_a - C_a)] + P_a C_a - (1 + \tau_v) P_v |X_v| \right. \\ \left. - g(X_l^h) + (1 - \tau_w) f(X_l^s) + E \right\} - \tau_G R_G$$

Here $U(\mathbf{c})$ is the farm household’s utility function (1), which assumed to be monotonic, twice differentiable, and concave in each of its arguments. Household maximizes utility defined over a vector of consumption goods $\mathbf{c} \in CG = \{C_m, C_a, C_l\}$ consisting of self-produced agricultural goods (C_a), a manufactured good (C_m) and leisure (C_l).

Production technology (2) is represented by a multi-output, multi-input transformation function ($G(\mathbf{x}, \mathbf{r}) = 0$), which is assumed to be well behaved in the usual sense (Lau 1978). Here, $\mathbf{x} \in PG = \{X_c, X_a, X_v, X_l\}$ is a vector of production goods, expressed as netputs, and \mathbf{r} is a vector of quasi-fixed factors consisting of factor land. The farm household is assumed to produce marketed agricultural goods, i.e. cash crops to be sold on markets, ($X_c > 0$) and home-consumed agricultural goods ($X_a > 0$) using variable inputs ($X_v < 0$), labor ($X_l < 0$), and the quasi-fixed factor land ($R_G > 0$).

The farm household faces a time constraint (3) where T_l denotes the total time available. $|X_l| = X_l^f + X_l^h$ is the total of on-farm labor time subdivided into family labor (X_l^f) and hired labor (X_l^h). Furthermore, X_l^s indicates off-farm family labor and C_l the leisure of the family members. In general, four regimes of labor market participation are possible. First, the farm household sells family labor and hires labor at the same time. Second, the household sells labor without hiring. Third, it hires without selling any family labor, or fourth, it neither sells nor hires labor, which can be referred to as autarky.

The budget constraint (4) implies that a household’s (‘tax-corrected’) total expenditure (left-hand side of (4)) must not exceed its (‘tax-corrected’) total income (right-hand side). Households may receive income from farming and from off-farm employment. In addition, it receives ($E > 0$) or pays ($E < 0$) transfers, which are determined exogenously. Here, $P_i; i = m, a, c, v$ denotes a vector of exogenous consumer and producer prices before tax, while τ_j is a vector of parameters of tax policies to be analyzed including a value-added tax (τ_{vat}), a market surplus tax (τ_{ms}), as well as taxes on inputs (τ_v), household’s monetary income (τ_y), off-farm wages (τ_w), and land (τ_G). It is assumed that all designed tax policies are alternative tax

instruments, so that the respective tax under consideration is the only tax policy applied to the farm household.²

Monetary expenditures are generally subject to value-added taxes. However, the internal transfers of self-produced agricultural goods are normally not observed by tax authorities. Thus, only the expenditures for market commodities ($P_m C_m$) are subject to the value-added tax (τ_{vat}). The basis of the income tax (τ_y) is the household's monetary income, including profits from farming ($P_c X_c + P_a X_a - P_v |X_v| - g(X_l^h)$), where $g(X_l^h)$ denotes hired labor costs (see below), and also off-farm labor income ($f(X_l^s)$), and transfers (E). Due to the virtual absence of record keeping, farm income is often not taxable and thus only incomes from off-farm employment can be taxed by a wage tax (τ_w). Similarly, market surplus, input, or land taxes are applied as surrogates for an income tax. The base of the market surplus tax (τ_{ms}) are revenues from sales of agricultural goods ($P_c X_c + P_a (X_a - C_a)$), assuming internal transfers are not taxable. Expenditures for commercial inputs ($P_v X_v$) such as fertilizer and chemicals are subject to the input tax (τ_v) and the market value of land (R_G) is taxed by a land tax (τ_G).

To consider labor market imperfections, revenues from off-farm employment and hired labor costs are conceptualized as functions of supplied $f(X_l^s)$ and hired $g(X_l^h)$ labor time. Under perfectly competitive labor markets, the functions are both linear, with $f(.) = P_l X_l^s$ or $g(.) = P_l X_l^h$. Hence, marginal off-farm income or marginal costs of hired labor are equal to the exogenous wage rate (P_l), in which case, the farm household model is said to be separable.

In contrast, when labor markets are imperfectly competitive, both supplied and hired labor functions become nonlinear with the following properties: $\partial f(.) / \partial X_l^s > 0$; $\partial^2 f(.) / \partial X_l^{s^2} < 0$ and $\partial g(.) / \partial X_l^h > 0$; $\partial^2 g(.) / \partial X_l^{h^2} > 0$, respectively. Now, off-farm income is an increasing and strictly concave function of supplied labor time. Analogously, the costs of hired labor are an increasing and strictly convex function of hired labor time. In this case, the price of labor and leisure (P_l) is endogenously determined and thus the farm household model is non-separable. The production and consumption decisions are simultaneously determined by the stationary solution of the equation system (1) to (4).

As indicated earlier, this framework is applicable to several kinds of labor market imperfections. In particular, it accounts for labor market imperfections that lead to a decreasing price effectively received for each further unit of off-farm employment and to an increasing price effectively paid for each further unit of hired labor time. Hence, such conditions can be interpreted as increasing per-unit costs of accessing labor markets, or as increasing transaction costs.

Increasing transaction costs associated with working off the farm may be caused by increasing heterogeneity between on- and off-farm family labor. With increasing migration, household members are first transferred to the 'best jobs', followed by the 'next best jobs' and

² We assume mutually exclusive tax instruments because we are interested mainly in partial effects of certain taxes on household decisions and not in the interaction effects of commonly imposed taxes. Involving such interactions would increase the intricacy of the theoretical model.

so on (Low 1982, 1986). Furthermore, increasing search and transportation costs may lead to a decreasing net wage rate. Increasing per-unit costs of hired labor may result from increasing search, supervision, and monitoring activities. These increases may stem from the growing difficulty in finding the ‘right’ staff for the different and often farm-specific areas of production, or the rising supervision and monitoring costs per-unit of hired labor, as the staff and hired labor time increases. Similarly, the existence of land-specific experience may lead to a decreasing substitutability between family and hired labor. Hired labor becomes less productive and the costs for a standardized hired labor unit increase.

Taking fixed costs³ of accessing labor markets into account might mainly contribute to the explanation of the different labor market participation regimes. The present paper does not analyze the different market participation regimes and thus does not explicitly model fixed transaction costs within the theoretical framework. It is assumed that the farm household hires on-farm and supplies off-farm labor simultaneously. The model presented here is applicable to all other market participation schemes.

The stationary solutions to the maximization problem (1)-(4) determine the optimal quantities of consumption and production goods, as well as the allocation of time, assuming there exists an interior solution (positive Lagrange multipliers for the constraints $\lambda, \phi, \mu > 0$ and positive optimal choice variables $c^*, x^* > 0$).

$$(5) \quad U_i(\cdot) - \lambda P_{Ci}^* = 0 \quad i \in CG = \{m, a, l\}$$

$$(6) \quad \phi G_i(\cdot) + \lambda P_{Pi}^* = 0 \quad i \in PG = \{c, a, v, l\}$$

$$(7) \quad f_l^*(\cdot) = P_l^* = g_l^*(\cdot)$$

$$(8) \quad \sum_{i \in \{c, a, v\}} P_{Pi}^* X_i - g^*(X_l^h) + f^*(X_l^s) - R_G^* + E^* - \sum_{i \in \{m, a\}} P_{Ci}^* C_i = 0$$

$$(9) \quad G(\mathbf{x}, \mathbf{r}) = 0$$

$$(10) \quad T_l + X_l + X_l^h - X_l^s - C_l = 0$$

where $\lambda, \phi > 0$ denote the Lagrangian multipliers associated with the budget and the technology constraints, respectively; U_i, G_i, f_l and g_l represent the first derivatives of the corresponding utility, production, and labor market functions. $P_l^* = \mu/\lambda$ denotes the unobservable internal wage in the case of non-separability, with μ as the Lagrangian multiplier associated with the time constraint. In the separable version, P_l^* indicates the exogenous ‘tax corrected’ wage rate. Furthermore, P_{Ci}^* and P_{Pi}^* represent the ‘tax corrected’ decision prices for consumption and production goods, respectively. Thus, the ‘tax corrected’ consumption price for manufactured goods is $P_{Cm}^* = (1 + \tau_{vat}) P_m$. Considering market surplus tax, the decision price for consumption

³ Note that the approach could additionally incorporate fixed costs of transactions that are invariant to the traded quantity, but also could affect the farm household’s decision to participate in markets (Sadoulet et al., 1996) for the labor markets; Goetz (1992) as well as Key et al. (2000) for food markets; Skoufias (1993), and Carter and Yao (2002) for the land market). Fixed transaction costs may include bargaining and negotiation efforts and transportation costs, often taking place once per transaction, and are invariant to the level of transaction.

of self-produced agricultural goods is $P_{Ca}^* = (1 - \tau_{ms})P_a$, however, it is equal to the market price before taxes $P_{Ca}^* = P_a$ if only the income tax has been imposed.⁴ Notably, the ‘tax corrected’ production price for home-consumed agricultural goods is $P_{Pa}^* = (1 - \tau_y)(1 - \tau_{ms})P_a$. Obviously, this price coincides with the consumption price in the case of market surplus tax $P_{Pa}^* = (1 - \tau_{ms})P_a$. However, given the existence of an income tax only, the ‘tax corrected’ production price P_{Pa}^* will be different from the consumption price P_{Ca}^* . Furthermore, the ‘tax corrected’ prices for marketed agricultural goods and variable inputs are indicated by $P_{Pc}^* = (1 - \tau_y)(1 - \tau_{ms})P_c$ and $P_{Pv}^* = (1 - \tau_y)(1 + \tau_v)P_v$, respectively. In addition, we define $R_G^* = \tau_G R_G$, $E^* = (1 - \tau_y)E$, $f^*(\cdot) = (1 - \tau_y)(1 - \tau_w)f(\cdot)$, and $g^*(\cdot) = (1 - \tau_y)g(\cdot)$.

3. Comparative static analysis

To facilitate the comparative static analysis, we transform the primal decision problem (1)-(4) into a dual representation (Diewert 1982). First we define a dual restricted profit function $\Pi(p_p^*, r) \equiv \max_x \{p_p^* x \mid G(x, r) = 0\}$, where p_p^* is the (decision) price vector of the production goods and $\Pi(p_p^*, r)$ is the maximal profit. Following Hotelling’s lemma, the optimal quantities of production goods are obtained by taking the first derivative of the profit function with respect to prices. Thus, $\partial \Pi(\cdot) / \partial P_{Pi}^* = X_i(p_p^*, r); \forall i \in \{c, a, v, l\}$.

We can also define a dual expenditure function as $e(p_c^*, U^\circ) \equiv \min_c \{p_c^* c \mid U(c) \geq U^\circ\}$, where p_c^* is the (decision) price vector of the consumption goods and U° is the obtainable utility level. According to Shepard’s lemma, the derived Hicksian compensated demand function can be given as $\partial e(\cdot) / \partial P_{Ci} = C_i^H(p_c^*, U^\circ); \forall i \in \{m, a, l\}$. Substituting the indirect utility function $V(p_c^*, Y)$ for U° , it holds that $C_i^H(p_c^*, V(p_c^*, Y)) \equiv C_i(p_c^*, Y)$. Thus, the Hicksian demand at utility $V(p_c^*, Y)$ is the same as the Marshallian demand at income Y .

For the non-separable model version, condition (7) defines the off-farm labor supply $X_l^s = X_l^s(P_l^*, \tau_j)$ and the demand for hired labor $X_l^h = X_l^h(P_l^*, \tau_j)$ as implicit functions of the endogenous labor price (P_l^*) and of those tax parameters (τ_y, τ_w) that (directly) affect the general wage level and hence the position of the labor market functions⁵.

Substituting the dual objective and the associated demand and supply functions into the time constraint (10) results in:

$$(11) \quad T_l + X_l(p_p^*, r) + X_l^h(P_l^*, \tau_j) - X_l^s(P_l^*, \tau_j) - C_l(p_c^*, Y) = 0,$$

⁴ Considering both regimes, decision price is $P_{Ca}^* = ((1 - \tau_{ms})(1 - \tau_y) + \tau_y)P_a$.

⁵ Here, the income tax affects the position of both functions, with $f^*(\cdot) = (1 - \tau_y)f(\cdot)$ and $g^*(\cdot) = (1 - \tau_y)g(\cdot)$, while the wage tax affects only the position of the first, with $f^*(\cdot) = (1 - \tau_w)f(\cdot)$.

where $Y = \Pi(.) - g^*[X_l^h(.)] + f^*[X_l^s(.)] + P_l^*[T_l + X_l^h(.) - X_l^s(.)] - R_G^* + E^* = \sum_{i \in CG} P_{Ci}^* C_i$.

Equation (11) implicitly defines the shadow wage (P_l^*) around the optimal solution of the non-separable model. Hence, $P_l^* = \chi(p_p^*, p_c^*, r, T_l, E^*, R_G^*, \tau_j)$ is an implicit function of exogenous decision prices for consumption and production goods (p_p^* and p_c^*), fixed resources (\mathbf{r}), total time available (T_l), land tax payments (R_G^*), and those tax parameters ($\tau_j \mid j = y, w$), which directly affect the wage level. Note that the impact of the other tax policies on the shadow price is already reflected by ‘tax-corrected’ exogenous prices.

Based on the above defined functions, we can derive farm household’s consumption, production and labor market responses ($Z = PG, CG, X_l^s, X_l^h$) to changes in any of the desired tax parameters ($\tau_j \mid j = y, w, ms, v, r, vat$). In the case of non-separability, we can decompose the tax-induced farm household reaction for any arbitrary tax policy into the following two components (de Janvry et al. 1991; Sonoda and Maruyama 1999):

$$(12) \quad \frac{\partial Z}{\partial \tau_j} = \frac{\partial Z}{\partial \tau_j} \bigg|_{P_l^* = \text{const.}} + \frac{\partial Z}{\partial P_l^*} \frac{\partial P_l^*}{\partial \tau_j}.$$

The first term (direct component) on the right-hand side represents the supply or demand reactions to changes in the tax parameters assuming a constant endogenous labor price (P_l^*). The second term (indirect component) represents the adjustments to the changes in the internal wage rate caused by changes in the same tax parameter.

In order to determine the indirect component of the non-separable model, we have to derive the tax-induced shadow price adjustment from equation (11), applying the implicit function theorem (de Janvry et al. 1991):

$$(13) \quad P_{l\tau_j}^* = \frac{\partial P_l^*}{\partial \tau_j} = - \frac{(X_{l\tau_j} + X_{l\tau_j}^h - X_{l\tau_j}^s - C_{l\tau_j}^H) - (C_{lY}\Psi)}{(X_{ll} + X_{ll}^h - X_{ll}^s - C_{ll}^H)}.$$

The numerator on the right-hand side represents the change in the time allocation due to increasing tax rates. Here, $X_{l\tau_j} = \sum_{i \in \{c, a, v\}} \frac{\partial X_l}{\partial P_{Pi}^*} \frac{\partial P_{Pi}^*}{\partial \tau_j}$ denotes tax-induced on-farm labor adjustment, and $X_{l\tau_j}^h = (\partial X_l^h / \partial \tau_j) \big|_{P_l^* = \text{const.}}$ and $X_{l\tau_j}^s = (\partial X_l^s / \partial \tau_j) \big|_{P_l^* = \text{const.}}$, respectively, are the direct labor market reactions to increasing income or wage taxes⁶. Furthermore, $C_{l\tau_j}^H = \sum_{i \in \{m, a\}} \frac{\partial C_l^H}{\partial P_{Ci}^*} \frac{\partial P_{Ci}^*}{\partial \tau_j}$ and $C_{lY}\Psi = (\partial C_l / \partial Y)\Psi$ are the tax-induced substitution and income

⁶ As noted before, direct labor market reactions result only for an income and a wage tax, since only these taxes directly affect the general wage level. Thus, the following direct tax-induced labor market reactions result:

$$\frac{\partial X_l^s}{\partial \tau_j} \bigg|_{P_l^* = \text{const.}} = - \frac{P_l^*}{(1 - \tau_j)} \bigg/ \frac{\partial^2 f^*(.)}{\partial X_l^{s^2}} < 0; (\tau_j \mid j = y, w), \text{ and } \frac{\partial X_l^h}{\partial \tau_y} \bigg|_{P_l^* = \text{const.}} = - \frac{P_l^*}{(1 - \tau_y)} \bigg/ \frac{\partial^2 g^*(.)}{\partial X_l^{h^2}} > 0.$$

effects with regard to the demand of leisure. Here, $\Psi = \left(\frac{\partial Y}{\partial \tau_j} - \sum_{i \in \{m,a\}} C_i \frac{\partial P_{Ci}^*}{\partial \tau_j} \right) \Big|_{P_i^* = \text{const.}}$ reflects the budget effects.

The denominator indicates the change in the time allocation caused by changes in the internal wage rate. Here, $X_{ll} = \partial X_l / \partial P_l^* > 0$, $X_{ll}^h = \partial X_l^h / \partial P_l^* = 1 / \left(\partial^2 g^*(.) / \partial X_l^{h^2} \right) > 0$, $X_{ll}^s = \partial X_l^s / \partial P_l^* = 1 / \left(\partial^2 f^*(.) / \partial X_l^{s^2} \right) < 0$ and $C_{ll}^H = \partial C_l / \partial P_l^* < 0$ ⁷. Note that the denominator is always positive given the convexity of $\Pi(.)$ and the concavity of $e(.)$ in prices, and given the convexity of $g^*(.)$ and the concavity of $f^*(.)$ in traded labor.

Substituting equation (13) into expression (12) yields farm household tax-induced economic adjustments:

$$(14) \quad \partial X_i / \partial \tau_j = X_{i\tau_j} + X_{il} P_{l\tau_j}^* \quad i = \{c, a, v, l\}$$

$$(15) \quad \partial C_i / \partial \tau_j = C_{i\tau_j}^H + C_{iY} \Psi + C_{il}^H P_{l\tau_j}^* \quad i = \{m, a, l\}$$

$$(16) \quad \partial X_l^s / \partial \tau_j = X_{l\tau_j}^s + X_{ll}^s P_{l\tau_j}^*$$

$$(17) \quad \partial X_l^h / \partial \tau_j = X_{l\tau_j}^h + X_{ll}^h P_{l\tau_j}^*.$$

Equation (14) indicates the tax-induced production adjustments, where $X_{i\tau_j} = \sum_{k \in \{c, a, v\}} \frac{\partial X_i}{\partial P_{Pk}^*} \frac{\partial P_{Pk}^*}{\partial \tau_j}$; $i = \{c, a, v, l\}$ denotes the respective direct component and $X_{il} P_{l\tau_j}^* = \frac{\partial X_i}{\partial P_l^*} \frac{\partial P_l^*}{\partial \tau_j}$, $i = \{c, a, v, l\}$ is the indirect component. Equation (15) represents household's consumption responses, where $C_{i\tau_j}^H = \sum_{k \in \{m, a\}} \frac{\partial C_i^H}{\partial P_{Ck}^*} \frac{\partial P_{Ck}^*}{\partial \tau_j}$ and $C_{iY} \Psi = \frac{\partial C_i}{\partial Y} \frac{\partial Y}{\partial \tau_j}$; $i = \{m, a, l\}$, respectively, are the tax-induced direct substitution and income effects; and $C_{il}^H P_{l\tau_j}^* = \frac{\partial C_i}{\partial P_l^*} \frac{\partial P_l^*}{\partial \tau_j}$; $i = \{m, a, l\}$ denotes the corresponding indirect component. The last two equations (16) and (17) represent farm household's adjustments to the supply of family off-farm labor and the demand for hired labor, respectively. Here, the first terms (right-hand side) are direct tax-induced adjustments, whereby the second terms indicate the indirect components (see above).

Under separability, in most cases farm household's economic adjustments coincide with the direct components of the non-separable version. This is particularly true for all production and consumption adjustments to changes in tax parameters which do not affect the general wage level ($\tau_j \mid j = ms, v, r, vat$). In contrast, they do not coincide with the direct components of the

⁷ Note that the full income effect of a changed internal wage strictly equals zero. This follows from partial differentiation of the full income constraint with regard to the internal wage.

separable version in the case of an income tax or a wage tax ($\tau_j \mid j = y, w$) since both directly affect the general wage level and hence shift the labor market functions. Regarding the labor markets, the comparative static of the separable version differs from the direct component of the non-separable version for all tax policies under consideration.⁸ The complete comparative statics derived in accordance with the equations (13) to (17) for all tax instruments mentioned above⁹ are summarized in Tables 1-6. In particular, we compare the tax-induced adjustments within the non-separable version with those of the separable framework.

Income tax

The comparative statics of an increasing income tax under imperfect labor markets and in the separable framework are summarized in Tables 1 and 1a, respectively. In the case of non-separability, an increase in the income tax results directly in a proportional decrease of all exogenous production prices $P_{pi}^*; i = \{c, a, v\}$ ¹⁰. This leads to a decrease in both output supply and demand for the variable input. On-farm labor demand will decrease (increase) if variable inputs and labor are complements (substitutes). In contrast, because an increasing income tax implies a falling internal wage rate, the indirect component initiates opposite adjustments. Since the internal wage likely decreases in a different proportion than the other production prices production responses to income taxes are probable but the overall direction is theoretically ambiguous. If labor markets are perfectly competitive (separable model version) an income tax proportionally affects all prices of the output supply and input demand functions. Since these functions are homogenous of degree zero, no tax-induced production adjustments result.¹¹ Obviously, production effects do not simply coincide with the direct component within the non-separable approach.

It is significant to note that the sign of the tax-induced consumption reactions are also theoretically undetermined within the non-separable framework. If the income effects (direct component) dictate the total effects, then the household reduces the consumption of all goods¹². If the indirect shadow price component is predominant, then the leisure demand increases while the consumption of market and self-produced goods decreases.¹³ Very similar adjustments are found within the separable approach. An increasing income tax directly reduces the exogenous wage and thus the value of leisure. Hence, the Hicksian substitution effect affects the demand in the same way as the indirect component in the case of non-separability and the income effect reduces households demand for all goods.

Also, the labor markets' responses are theoretically ambiguous. While the direct component implies a decreasing off-farm employment and an increasing demand for hired labor, the opposite holds for the respective indirect components. In the case of separability, the labor market reactions residually result after production and consumption decisions are made.

⁸ In the case of separability, labor market adjustments residually result from the time constraint, after production and consumption decisions are made: $\partial(T_l + X_l - C_l)/\partial\tau_j$.

⁹ On request, a detailed documentation of the comparative static analysis is available from the authors.

¹⁰ Falling exogenous production prices enforce the same production adjustments as an increasing price for labor.

¹¹ Homogeneity of degree zero in prices follows from the linear homogeneity of the profit function in prices.

¹² As long as the goods are not inferior.

¹³ Assuming substitutive relationships in consumption.

Because there are no tax-induced production effects, the labor market adjustment is the reverse of the tax-induced change in the leisure demand. If the household supplies off-farm labor, then the substitution effect implies a decrease in off-farm labor, and the income effect results in the opposite. In the case where farmers hire additional on-farm labor, the contrary result is obtained.

Wage tax

Farm household adjustments as a result of an increasing wage tax under imperfect labor markets are represented in the Table 2. Assuming imperfectly competitive labor markets, a wage tax will have no direct impact on farmer's production decisions. It, however results in a reduction in the internal valuation of labor, inducing farmers to raise output supply and to intensify on-farm labor and the use of variable inputs, if they are complements to labor. With regard to consumption and off-farm labor adjustments, the theoretical effects of a wage tax are similar to those of an income tax, probably not in magnitude, but rather in direction (see above). The reduction of hired labor as a result of an increased wage tax appears to be surprising. However, a lower internal wage rate implies that family labor becomes less expensive compared to hired on-farm labor. Therefore, hired labor will be substituted as long as their marginal cost equals the reduced shadow wage.

Within the separable model version, an increasing wage tax implies a lower exogenous net wage rate for off-farm employment¹⁴ and thus affects only farm households that are labor suppliers. The production and consumption adjustments are very similar to those of the non-separable model (see Table 2a). Here, the direct tax-induced production effects and the direct Hicksian substitution effects correspond to the indirect shadow price components in the case of non-separability. Also, the adjustment regarding off-farm labor supply is not clearly determined. While the direct production effect and Hicksian substitution effect reduce the tendency to work off-farm, the income effect supports via the decreasing demand the opposite.¹⁵

Market surplus tax

To analyze the impact of the market surplus tax (τ_{ms}) it is crucial to differentiate between net sellers and net buyers of the self-produced agricultural goods. With a view towards applications of this model for low-income economies, it seems reasonable to assume that the household is a net supplier ($X_a - C_a > 0$).

The comparative statics of an increasing market surplus tax under imperfect labor markets are summarized in Tables 3. Similar to both tax policies discussed above, the production and consumption adjustments of farm households to a market surplus tax are theoretically ambiguous. An increasing market surplus tax reduces the output prices, and leads via the direct component to a reduction in both the output supply and labor demand and a

¹⁴ In general, an imposition of a wage tax leads in the separable model version to differences ($P_l^{ss} < P_l^{hs}$) between the exogenous price for hired labor (P_l^{hs}) and the exogenous price for off-farm labor (P_l^{ss}). Thus, the price for hired labor is greater than that of off-farm family labor. Under some circumstances, such a pattern of exogenous labor prices hinders household members from participating in the off-farm labor market and enforces them to work exclusively on the farm. Such a situation represents the 'classical' case of a non-separable farm household framework, where labor markets completely fail.

¹⁵ Similar to the income tax, the comparative statics of the separable model do not coincide with the direct component of the non-separable framework.

decreasing demand of variable inputs. The adjustment of the internal wage as a result of an increased market surplus tax is not clearly determined. However, for substitutive relations between leisure and self-produced consumption goods, the shadow wage does decrease. Because a substitutive relation seems to be more probable than a complementary one, we assume a decreasing internal wage. Under this assumption, the indirect component affects production in the opposite direction. Furthermore, as a market surplus tax leads to a lower value of self-produced consumption goods, it causes via Hicksian net-substitution a higher demand for these self-produced goods but a lower demand for market goods and leisure (assuming all consumption goods are net-substitutes). The indirect shadow price component leads to consumption adjustments in the opposite direction. Albeit these counteracting effects, a predominance of the direct income effect appears to be probable, i.e., the market surplus tax likely reduces the demand for all goods. Finally, since no direct labor market effects exist, a lower internal wage causes an additional supply of off-farm family work and a reduction of hired labor.

In general, the effects of market surplus tax on production, and consumption, as well as labor market under separability are somewhat different to those of the non-separable framework (see Table 3a). Strictly speaking the production and consumption adjustment assuming separability does correspond to the direct effect in the non-separable framework. Therefore output supply as well as demand for variable inputs including labor will be reduced. Further, a market surplus tax will probably reduce the demand for all consumption goods, assuming a predominance of the income effect. While production and consumption will be reduced, the household either increases the off-farm employment or demands less hired labor.

Input tax

Farm household's adjustments as a result of an increasing income tax are represented in Tables 4 and 4a. An increasing input tax implies a higher exogenous (decision) price of commercial inputs, which leads to an ambiguous adjustment of the internal wage rate. If the direct tax-induced (negative) production effect predominates the internal valuation of time, then the shadow wage will increase as long as labor and commercial inputs are substitutes in the production. If they are complements in production or the (negative) income effect on the consumption side dictates the total effect, then the input tax leads to a reduction of the shadow wage. Because of the undetermined change of the internal wage, the direction of production and consumption responses is theoretically ambiguous, too.

The higher price for commercial inputs causes via the direct component a lower output supply and lower demand for commercial inputs and on-farm labor¹⁶. While an increasing internal wage enforces the production adjustments in the same direction, a decreasing shadow wage leads to the opposite reactions, and most direct effects will be compensated. On the consumption side, an input tax results in a reduction of consumption as a result of the direct income effect. However, a reduced (increased) internal wage rate leads to a higher (lower) demand for leisure. As in the case of a market surplus tax, an input tax, under a lower internal wage, leads to an increase in off-farm labor supply and a decrease in hired labor. The opposite responses will occur under the assumption of a higher internal wage.

The consumption and production adjustments within the separable framework are similar to those of the non-separable model. The labor market reactions are clearly determined for complementary relationships between commercial inputs and on-farm labor input. In this

¹⁶ As long as labor and commercial inputs are complements in production.

case, the production and income effects induce either an increase in off-farm labor supply or a decrease in the demand for hired labor.¹⁷

Land tax

The impact of a land tax on production, consumption and labor markets is summarized in Tables 5 and 5a. A land tax causes a “devaluation” of the internal wage rate via a negative direct income effect. This leads to an intensification of on-farm labor input via a reduced shadow wage, resulting in a higher output supply. Obviously, when labor markets are imperfectly competitive, a land tax leads to production adjustments. Changes in consumption are similar to those under the input tax regime. In addition, off-farm employment increases, while the demand for hired labor will decrease.

In the case of perfectly competitive labor markets, a land tax does not affect production decisions. The consumption reactions coincide with the direct income effect, i.e., a decrease in demand for all goods. As expected, the taxation of land causes either an increase in off-farm employment or a decrease in demand for hired labor.

Value added tax

Farm household adjustments resulting from a value added tax are reported in Tables 6 and 6a. An increase in the value-added tax implies a higher exogenous price only for purchased consumptions goods, as long as the value of self-produced agricultural goods cannot be observed by tax authorities. However, the resulting adjustment of the internal wage rate is not uniquely determined. As long as a value-added tax results in a higher demand for leisure, that is, substitutional relationships occur in the Marshallian demand, the internal valuation of time will increase. The opposite is true for a tax-induced decreasing demand for leisure.

A higher (lower) internal wage will result in a decrease (increase) in labor demand and output supply. In contrast to the production response, household’s tax-induced consumption decisions are unclear. The higher price of market goods results in a direct fall in demand for market goods, but an ambiguous adjustment with regard to the consumption of self-produced goods and leisure. However, a higher (lower) endogenous valuation of leisure leads to an increase (decrease) in demand for market and self-produced goods. Furthermore, a higher (lower) internal wage reduces (increases) off-farm employment, while increasing (decreasing) the demand for hired labor.

In contrast, if separability is assumed, no tax-induced production adjustments occur, and the consumption responses are similar to those of the non-separable framework. As in the case of the non-separable version, labor market adjustments are analytically ambiguous. If the Hicksian effect is predominant and there are substitutive relationships in consumption, then either off-farm labor will decrease or the demand for hired labor will increase. If leisure and purchased consumption goods are complements, or the income effect is predominant, then farmers react in the opposite manner on the labor markets.

¹⁷ If the inputs are substitutes in production, and the production effect predominates, then the opposite adjustments hold.

In summary, the impacts of taxation on agricultural households are fundamentally an empirical question amid the often incomplete markets and non-separable household decision-making in poor agrarian economies.¹⁸

4. Concluding Remarks

This paper provides a comparative static analysis of farm household's production, consumption, and labor market decisions under alternative tax policies. We explore the implications of non-separable household decisions caused by widespread non-participation in labor, land, financial and/or food markets, as is typical of low income economies. To explicitly control for tax-induced adjustments related to labor market imperfections, we compare the results to those derived from a separable approach assuming perfect labor markets. In detail, we analyze an income and a value-added tax, which are the usual tax tools of non-peasant households but often difficult to implement in agricultural households. Thus, we also examine an off-farm income tax as well as typical agricultural taxes (market surplus, input, and land taxes), which are treated as surrogates for standard taxes.

The analytical results indicate that when labor market imperfections occur most tax-induced responses are ambiguous, mainly due to shadow price effects. This is particularly the case for the labor market and production responses to most tax tools under study, while a decreasing demand for consumption goods appears to be the result in several cases. Furthermore, tax-induced allocation effects may differ between the non-separable and the separable model versions, indicating the potential impact of labor market constraints on farm household responses to tax policies. In particular, standard taxes as well as a land tax may imply production adjustments in the case of non-separability.

Methodologically, the analysis shows that using partial equilibrium or separable household models to analyze tax policies might be inappropriate when market imperfections create non-separabilities, as will be typical for labor markets in agrarian economies. The model explicitly accounts for several kinds of labor market imperfections (e.g., institutional restrictions or fixed and variable transaction costs in accessing labor markets), and is applicable to different labor market regimes, including the case that households both hire on-farm and sell off-farm labor.

From a policy perspective, the work contributes to the on-going debate over agricultural tax reforms and the implementation of well-defined tax systems in less-developed and transition economies. In contrast to most studies, our theoretical results advise that income and value-added taxes are not necessarily superior to agricultural taxes in the sense of optimal taxation theory (Diamond and Mirrlees 1971). Analogously, since a land tax might imply production adjustments and thus efficiency losses, it is not clearly superior to market surplus or input taxes as most studies suggest.

¹⁸ The empirical analysis of the farm household responses to tax policies could be carried out econometrically following the procedure suggested by Jacoby (1993) and Bejamin (1992). In order to test for separability and, if rejected, to get an estimate of the internal wage total labor demand will be regressed on farm and off-farm wage rates, household structure and land. In a second step the profit function approach will be used to estimate output supply and input demand given the estimated shadow wage and other exogenous variables as a system of seemingly unrelated functions.

5. References

- Abdulai, A., Delgado, C.L. (1999). Determinants of Nonfarm Earnings of Farm-Based Husbands and Wives in Northern Ghana. *American Journal of Agricultural Economics*, 81, 117-130.
- Ahmad, E., Stern, N. (1991). *The Theory and Practice of Tax Reform in Developing Countries*. Cambridge, MA: Cambridge University Press.
- Atkinson, A.B. (1987). The Theory of Tax Design for Developing Countries. In D. Newbery, Stern, N. (Eds.), *The Theory of Taxation for Developing Countries* (pp. 387-404). New York: Oxford University Press.
- Bahl, R. (2006). How to Approach Comprehensive Tax Reform: Have the Rules of the Game Changed? In J. Alm, Martinez-Vazquez, J., Rider, M. (Eds.), *The Challenges of Tax Reform in a Global Economy* (pp. 447-471). New York: Springer.
- Benjamin, D. (1992). Household Composition, Labor Market, and Labor Demand: Testing for Separation in Agricultural Household Models. *Econometrica*, 60, 287-322.
- Bird, R.M. (1974). *Taxing Agricultural Land in Developing Countries*. Cambridge, MA: Harvard University Press.
- Burgess, R., Stern, N. (1993). Taxation and Development. *Journal of Economic Literature*, 31, 762-830.
- Carter, M.R., Yao, Y. (2002). Local versus Global Separability in Agricultural Household Models: The Factor Price Equalization Effect of Land Transfer Rights. *American Journal of Agricultural Economics*, 84, 702-715.
- Chambers, R.G., Lopez, R.E. (1987). Tax Policies and the Financially Constrained Farm Household. *American Journal of Agricultural Economics*, 69, 969-377.
- de Janvry, A., Fafchamps, M., Sadoulet, E. (1991). Peasant Household Behaviour with Missing Markets: Some Paradoxes Explained. *Economic Journal*, 101, 1400-1417.
- Deolalikar, A.B., Vijverberg, W.P.M (1987). A Test of Heterogeneity of Family and Hired Labour in Asian Agriculture. *Oxford Bulletin of Economics and Statistics*, 49, 291-305.
- Diamond, P.A., Mirrlees, J. (1971). Optimal Taxation and Public Production, Part I: Production Efficiency. *American Economic Review*, 61, 8-27.
- Diewert, W.E. (1982). Duality Approaches to Microeconomic Theory. In Arrow, K.J., Intriligator, M.D. (Eds.), *Handbook of Mathematical Economics*, Vol. II (pp. 536-599). Amsterdam/ New York/ Oxford: North-Holland.
- Emran, M.S., Stiglitz, J.E. (2005). On Selective Indirect Tax Reform in Developing Countries. *Journal of Public Economics*, 89, 599-623.
- Fafchamps, M. (1992). Cash Crop Production, Food Price Volatility, and Rural Market Integration in the Third World. *American Journal of Agricultural Economics*, 74, 90-99.
- Finkelstein, I., Chalfant, J.A. (1991). Marketed Surplus Under Risk: Do Peasants Agree with Sandmo? *American Journal of Agricultural Economics*, 73, 557-567.

- Goetz, S.J. (1992). A Selectivity Model of Household Food Marketing Behavior in Sub-Sahara Africa. *American Journal of Agricultural Economics*, 74, 444-452.
- Gordon, R., Li, W. (2009). Tax Structures in Developing Countries: Many Puzzles and a Possible Explanation. *Journal of Public Economics*, 93, 855–866.
- Heady, C.J., Mitra, P.K. (1987). Optimal Taxation and Shadow Pricing in a Developing Economy. In Newbery, D., Stern, N. (Eds.), *The Theory of Taxation for Developing Countries* (pp. 407-425). New York: Oxford University Press.
- Jacoby, H. (1993). Shadow Wages and Peasant Family Labour Supply: An Econometric Application to the Peruvian Sierra. *Review of Economic Studies*, 60, 903-921
- Khan, M.H. (2001). Agricultural Taxation in Developing Countries: A Survey of Issues and Policy. *Agricultural Economics*, 24, 315–328.
- Key, N., Sadoulet, E., de Janvry, A. (2000). Transaction Costs and Agricultural Household Supply Response. *American Journal of Agricultural Economics*, 82, 245-259.
- Lau, L.J. (1978). Applications of Profit Functions. In Fuss, M., McFadden, D. (Eds.), *Production Economics: A Dual Approach to Theory and Applications* (pp. 133-216). Amsterdam/ New York/ Oxford: North-Holland.
- Löfgren, H., Robinson, S. (1999). Nonseparable Farm Household Decisions in a Computable General Equilibrium Model. *American Journal of Agricultural Economics*, 81, 663-670.
- Lopez, R.E. (1994). Estimating Labor Supply and Production Decisions of Self-Employed Farm Producers. *European Economic Review*, 24, 61-82.
- Low, A. (1982). Farm-Household Theory and Rural Development in Swaziland. Development Study No. 23, Economic and Social Committee for Overseas Research, University of Reading.
- Low, A. (1986). *Agricultural Development in Southern Africa: Farm-Household Economics and the Food Crisis*. London: Currey.
- Munk, K.J. (1980). Optimal Taxation with some Non-Taxable Commodities. *Review of Economic Studies*, 47, 755-766.
- Newbery, D. (1987). Structural Issues and Taxation. In Newbery, D., Stern, N. (Eds.), *The Theory of Taxation for Developing Countries* (pp. 163-204). New York: Oxford University Press.
- Rao, J.M. (1989). Taxing Agriculture: Instruments and Incidence. *World Development*, 17, 809-823.
- Sadoulet, E., de Janvry, A., Benjamin, C. (1996). Labor Market Imperfections and Selective Separability in Household Models: A Predictive Typology of Mexican Ejidatarios. Working Paper No. 786, University of California, Berkeley.
- Sah, R.K., Stiglitz, J.E. (1987). The Taxation and Pricing of Agricultural and Industrial Goods in Developing Economies. In Newbery, D., Stern, N. (Eds.), *The Theory of Taxation for Developing Countries* (pp. 426-461). New York: Oxford University Press.

Skinner, J. (1991). Prospects for Agricultural Land Taxation in Developing Countries. *World Bank Economic Review*, 5, 493–511.

Skoufias, E. (1993) Labor Market Opportunities and Intra-family Time Allocation in Rural Households in South Asia. *Journal of Developing Economics*, 40, 277-310.

Sonoda, T., Maruyama, Y. (1999). Effects of the Internal Wage on Output Supply: A Structural Estimation of Japanese Rice Farmers. *American Journal of Agricultural Economics*, 81, 131-143.

Stiglitz, J.E., Dasgupta, P.S. (1971). Differential Taxation, Public Goods, and Economic Efficiency. *Review of Economic Studies*, 38, 151-178.

Strauss, J. (1986). The Theory and Comparative Statics of Agricultural Household Models: A General Approach. In Singh, I.J., Squire, L., Strauss, J. (Eds.), *Agricultural Household Models* (pp. 17-47). Baltimore: John Hopkins University Press.

Table 1: Comparative statics for income tax in non-separable model

$\tau_j = \tau_y$		Direct tax-induced labor market reactions		Direct effect from tax-induced price changes of PG			Indirect effect on PG	Direct income effect	Direct substitution effect from price changes of CG		Indirect effect on CG
		X_l^h	X_l^s	p_{Pc}^*	p_{Pa}^*	p_{Pv}^*			p_{Cm}^*	p_{Ca}^*	
$\frac{\partial Z_i}{\partial \tau_j}$		$\left. \frac{\partial X_l^h}{\partial \tau_j} \right _{p_i^* = \text{const}}$	$\left. \frac{\partial X_l^s}{\partial \tau_j} \right _{p_i^* = \text{const}}$	$\frac{\partial X_i}{\partial p_{Pc}^*} \frac{\partial p_{Pc}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pa}^*} \frac{\partial p_{Pa}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pv}^*} \frac{\partial p_{Pv}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial Y} \Psi$	$\frac{\partial C_i}{\partial p_{Cm}^*} \frac{\partial p_{Cm}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_{Ca}^*} \frac{\partial p_{Ca}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$
Shadow price	$\frac{\partial p_l^*}{\partial \tau_j} < 0$	$> 0^1$	$< 0^2$	$< 0^3$	$< 0^3$	$(> 0^4)^3$	-	$< 0^{2,6}$	$= 0$	$= 0$	-
Labor market responses	$\frac{\partial X_l^h}{\partial \tau_j} = ?$	$> 0^1$	-	-	-	-	$< 0^1$	-	-	-	-
	$\frac{\partial X_l^s}{\partial \tau_j} = ?$	-	$< 0^2$	-	-	-	$> 0^2$	-	-	-	-
Production responses	$\frac{\partial X_{c,a}}{\partial \tau_j} = ?$	-	-	$< 0^3$	$< 0^3$	$> 0^3$	$> 0^3$	-	-	-	-
	$\frac{\partial X_v}{\partial \tau_j} = ?$	-	-	$< 0^3$	$< 0^3$	$> 0^3$	$(> 0^4)^3$	-	-	-	-
	$\frac{\partial X_l}{\partial \tau_j} = ?$	-	-	$< 0^3$	$< 0^3$	$(> 0^4)^3$	$> 0^3$	-	-	-	-
Consumption responses	$\frac{\partial C_m}{\partial \tau_j} = ? (< 0)$	-	-	-	-	-	-	$< 0^6$	$= 0$	$= 0$	$(< 0^7)^5$
	$\frac{\partial C_a}{\partial \tau_j} = ? (< 0)$	-	-	-	-	-	-	$< 0^6$	$= 0$	$= 0$	$(< 0^7)^5$
	$\frac{\partial C_l}{\partial \tau_j} = ?$	-	-	-	-	-	-	$< 0^6$	$= 0$	$= 0$	$> 0^5$

Table 1a: Comparative statics for income tax in separable model

$\tau_j = \tau_y$		Direct tax-induced labor market reactions		Direct effect from tax-induced price changes of PG				Direct income effect	Direct substitution effect from price changes of CG		
		X_l^h	X_l^s	p_{Pc}^*	p_{Pa}^*	p_{Pv}^*	p_l^*		p_{Cm}^*	p_{Ca}^*	p_l^*
$\frac{\partial Z_i}{\partial \tau_j}$		$\left. \frac{\partial X_l^h}{\partial \tau_j} \right _{p_l^* = const}$	$\left. \frac{\partial X_l^s}{\partial \tau_j} \right _{p_l^* = const}$	$\frac{\partial X_i}{\partial p_{Pc}^*} \frac{\partial p_{Pc}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pa}^*} \frac{\partial p_{Pa}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pv}^*} \frac{\partial p_{Pv}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial Y} \Psi$	$\frac{\partial C_i}{\partial p_{Cm}^*} \frac{\partial p_{Cm}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_{Ca}^*} \frac{\partial p_{Ca}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$
Labor market	$\frac{\partial (X_l^s - X_l^h)}{\partial \tau_j} = ?$	-	-	$< 0^3$	$< 0^3$	$> 0^3$	$> 0^3$	$< 0^6$	-	-	$> 0^5$
Production responses	$\frac{\partial X_{c,a}}{\partial \tau_j} = 0^8$	-	-	$< 0^3$	$< 0^3$	$> 0^3$	$> 0^3$	-	-	-	-
	$\frac{\partial X_v}{\partial \tau_j} = 0^8$	-	-	$< 0^3$	$< 0^3$	$> 0^3$	$(> 0^4)^3$	-	-	-	-
	$\frac{\partial X_l}{\partial \tau_j} = 0^8$	-	-	$< 0^3$	$< 0^3$	$(> 0^4)^3$	$> 0^3$	-	-	-	-
Consumption responses	$\frac{\partial C_m}{\partial \tau_j} = ? (< 0)$	-	-	-	-	-	-	$< 0^6$	= 0	= 0	$< 0^{5,7}$
	$\frac{\partial C_a}{\partial \tau_j} = ? (< 0)$	-	-	-	-	-	-	$< 0^6$	= 0	= 0	$< 0^{5,7}$
	$\frac{\partial C_l}{\partial \tau_j} = ?$	-	-	-	-	-	-	$< 0^6$	= 0	= 0	$> 0^5$

Notes: Following assumptions were considered by deriving the comparative statics: ¹ convexity of $g^*(.)$ in X_l^h ; ² concavity of $f^*(.)$ in X_l^s ; ³ concavity of $\Pi(.)$ in $p_i (i \in PG)$; ⁴ X_v and X_l are complements; ⁵ convexity of $e(.)$ in $p_i (i \in CG)$; ⁶ C_a, C_m and C_l are normal goods; ⁷ C_a are substitutes for C_l .

Table 2: Comparative statics for wage tax in non-separable model

$\tau_j = \tau_w$		Direct tax-induced labor market reactions		Direct effect from tax-induced price changes of PG			Indirect effect on PG	Direct income effect	Direct substitution effect from price changes of CG		Indirect effect on CG
		X_l^h	X_l^s	p_{Pc}^*	p_{Pa}^*	p_{Pv}^*			p_{Cm}^*	p_{Ca}^*	
$\frac{\partial Z_i}{\partial \tau_j}$		$\left. \frac{\partial X_l^h}{\partial \tau_j} \right _{P_l^* = const}$	$\left. \frac{\partial X_l^s}{\partial \tau_j} \right _{P_l^* = const}$	$\frac{\partial X_i}{\partial p_{Pc}^*} \frac{\partial p_{Pc}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pa}^*} \frac{\partial p_{Pa}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pv}^*} \frac{\partial p_{Pv}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial Y} \Psi$	$\frac{\partial C_i}{\partial p_{Cm}^*} \frac{\partial p_{Cm}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_{Ca}^*} \frac{\partial p_{Ca}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$
Shadow price	$\frac{\partial P_l^*}{\partial \tau_j} < 0$	= 0	< 0 ²	= 0	= 0	= 0	-	< 0 ^{2,6}	= 0	= 0	-
Labor market responses	$\frac{\partial X_l^h}{\partial \tau_j} < 0$	= 0	-	-	-	-	< 0 ¹	-	-	-	-
	$\frac{\partial X_l^s}{\partial \tau_j} = ?$	-	< 0 ²	-	-	-	> 0 ²	-	-	-	-
Production responses	$\frac{\partial X_{c,a}}{\partial \tau_j} > 0$	-	-	= 0	= 0	= 0	> 0 ³	-	-	-	-
	$\frac{\partial X_v}{\partial \tau_j} = ? (> 0^4)$	-	-	= 0	= 0	= 0	(> 0 ⁴) ³	-	-	-	-
	$\frac{\partial X_l}{\partial \tau_j} > 0$	-	-	= 0	= 0	= 0	> 0 ³	-	-	-	-
Consumption responses	$\frac{\partial C_m}{\partial \tau_j} = ? (< 0^5)$	-	-	-	-	-	-	< 0 ⁶	= 0	= 0	(< 0 ⁷) ⁵
	$\frac{\partial C_a}{\partial \tau_j} = ? (< 0^5)$	-	-	-	-	-	-	< 0 ⁶	= 0	= 0	(< 0 ⁷) ⁵
	$\frac{\partial C_l}{\partial \tau_j} = ?$	-	-	-	-	-	-	< 0 ⁶	= 0	= 0	> 0 ⁵

Table 2a: Comparative statics for wage tax in separable model

$\tau_j = \tau_w$		Direct tax-induced labor market reactions		Direct effect from tax-induced price changes of PG				Direct income effect	Direct substitution effect from price changes of CG		
		X_l^h	X_l^s	p_{Pc}^*	p_{Pa}^*	p_{Pv}^*	p_l^*		p_{Cm}^*	p_{Ca}^*	p_l^*
$\frac{\partial Z_i}{\partial \tau_j}$		$\left. \frac{\partial X_l^h}{\partial \tau_j} \right _{p_l^* = const}$	$\left. \frac{\partial X_l^s}{\partial \tau_j} \right _{p_l^* = const}$	$\frac{\partial X_i}{\partial p_{Pc}^*} \frac{\partial p_{Pc}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pa}^*} \frac{\partial p_{Pa}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pv}^*} \frac{\partial p_{Pv}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial Y} \Psi$	$\frac{\partial C_i}{\partial p_{Cm}^*} \frac{\partial p_{Cm}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_{Ca}^*} \frac{\partial p_{Ca}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$
Labor market	$\frac{\partial (X_l^s - X_l^h)}{\partial \tau_j} = ?$	-	-	$= 0^3$	$= 0^3$	$= 0^3$	$> 0^3$	$< 0^6$	-	-	$> 0^5$
Production responses	$\frac{\partial X_{c,a}}{\partial \tau_j} > 0$	-	-	$= 0^3$	$= 0^3$	$= 0^3$	$> 0^3$	-	-	-	-
	$\frac{\partial X_v}{\partial \tau_j} = ? (> 0^4)$	-	-	$= 0^3$	$= 0^3$	$= 0^3$	$(> 0^4)^3$	-	-	-	-
	$\frac{\partial X_l}{\partial \tau_j} > 0$	-	-	$= 0^3$	$= 0^3$	$= 0^3$	$> 0^3$	-	-	-	-
Consumption responses	$\frac{\partial C_m}{\partial \tau_j} = ? (< 0^5)$	-	-	-	-	-	-	$< 0^6$	$= 0$	$= 0$	$(< 0^7)^5$
	$\frac{\partial C_a}{\partial \tau_j} = ? (< 0^5)$	-	-	-	-	-	-	$< 0^6$	$= 0$	$= 0$	$(< 0^7)^5$
	$\frac{\partial C_l}{\partial \tau_j} = ?$	-	-	-	-	-	-	$< 0^6$	$= 0$	$= 0$	$> 0^5$

Notes: Following assumptions were considered by deriving the comparative statics: ¹ convexity of $g^*(.)$ in X_l^h ; ² concavity of $f^*(.)$ in X_l^s ; ³ concavity of $\Pi(.)$ in $p_i (i \in PG)$; ⁴ X_v and X_l are complements; ⁵ convexity of $e(.)$ in $p_i (i \in CG)$; ⁶ C_a, C_m and C_l are normal goods; ⁷ C_a are substitutes for C_l .

Table 3: Comparative statics for market surplus tax in non-separable model

$\tau_j = \tau_{ms}$		Direct tax-induced labor market reactions		Direct effect from tax-induced price changes of PG			Indirect effect on PG	Direct income effect	Direct substitution effect from price changes of CG		Indirect effect on CG
		X_l^h	X_l^s	p_{Pc}^*	p_{Pa}^*	p_{Pv}^*			p_{Cm}^*	p_{Ca}^*	
$\frac{\partial Z_i}{\partial \tau_j}$		$\left. \frac{\partial X_l^h}{\partial \tau_j} \right _{P_l^* = const}$	$\left. \frac{\partial X_l^s}{\partial \tau_j} \right _{P_l^* = const}$	$\frac{\partial X_i}{\partial p_{Pc}^*} \frac{\partial p_{Pc}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pa}^*} \frac{\partial p_{Pa}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pv}^*} \frac{\partial p_{Pv}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial Y} \Psi$	$\frac{\partial C_i}{\partial p_{Cm}^*} \frac{\partial p_{Cm}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_{Ca}^*} \frac{\partial p_{Ca}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$
Shadow price	$\frac{\partial P_l^*}{\partial \tau_j} = ? (< 0^7)$	= 0	= 0	< 0 ³	< 0 ³	= 0	-	< 0 ^{2,6}	= 0	< 0 ^{5,7}	-
Labor market responses	$\frac{\partial X_l^h}{\partial \tau_j} = ?$	= 0	-	-	-	-	? (< 0) ¹	-	-	-	-
	$\frac{\partial X_l^s}{\partial \tau_j} = ?$	-	= 0	-	-	-	? (> 0) ²	-	-	-	-
Production responses	$\frac{\partial X_{c,a}}{\partial \tau_j} = ?$	-	-	< 0 ³	< 0 ³	= 0	(> 0) ³	-	-	-	-
	$\frac{\partial X_v}{\partial \tau_j} = ?$	-	-	< 0 ³	< 0 ³	= 0	(> 0 ⁴) ³	-	-	-	-
	$\frac{\partial X_l}{\partial \tau_j} = ?$	-	-	< 0 ³	< 0 ³	= 0	(> 0 ⁴) ³	-	-	-	-
Consumption responses	$\frac{\partial C_m}{\partial \tau_j} = ? (< 0^7)$	-	-	-	-	-	-	< 0 ⁶	= 0	(< 0 ⁷) ⁵	(< 0 ⁷) ⁵
	$\frac{\partial C_a}{\partial \tau_j} = ?$	-	-	-	-	-	-	< 0 ⁶	= 0	> 0	(< 0 ⁷) ⁵
	$\frac{\partial C_l}{\partial \tau_j} = ?$	-	-	-	-	-	-	< 0 ⁶	= 0	(< 0 ⁷) ⁵	(> 0) ⁵

Table 3a: Comparative statics for market surplus tax in separable model

$\tau_j = \tau_{ms}$		Direct tax-induced labor market reactions		Direct effect from tax-induced price changes of PG				Direct income effect	Direct substitution effect from price changes of CG		
		X_l^h	X_l^s	p_{Pc}^*	p_{Pa}^*	p_{Pv}^*	p_l^*		p_{Cm}^*	p_{Ca}^*	p_l^*
$\frac{\partial Z_i}{\partial \tau_j}$		$\left. \frac{\partial X_l^h}{\partial \tau_j} \right _{p_l^* = const}$	$\left. \frac{\partial X_l^s}{\partial \tau_j} \right _{p_l^* = const}$	$\frac{\partial X_i}{\partial p_{Pc}^*} \frac{\partial p_{Pc}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pa}^*} \frac{\partial p_{Pa}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pv}^*} \frac{\partial p_{Pv}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial Y} \Psi$	$\frac{\partial C_i}{\partial p_{Cm}^*} \frac{\partial p_{Cm}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_{Ca}^*} \frac{\partial p_{Ca}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$
Labor market	$\frac{\partial (X_l^s - X_l^h)}{\partial \tau_j} (> 0)$	-	-	$< 0^3$	$< 0^3$	$= 0$	$= 0$	$< 0^6$	-	$< 0^{5,7}$	$= 0$
Production Responses	$\frac{\partial X_{c,a}}{\partial \tau_j} < 0$	-	-	$< 0^3$	$< 0^3$	$= 0$	$= 0$	-	-	-	-
	$\frac{\partial X_v}{\partial \tau_j} < 0$	-	-	$< 0^3$	$< 0^3$	$= 0$	$= 0$	-	-	-	-
	$\frac{\partial X_l}{\partial \tau_j} < 0$	-	-	$< 0^3$	$< 0^3$	$= 0$	$= 0$	-	-	-	-
Consumption responses	$\frac{\partial C_m}{\partial \tau_j} = ? (< 0)^7$	-	-	-	-	-	-	$< 0^6$	$= 0$	$< 0^{5,7}$	$= 0$
	$\frac{\partial C_a}{\partial \tau_j} = ?$	-	-	-	-	-	-	$< 0^6$	$= 0$	> 0	$= 0$
	$\frac{\partial C_l}{\partial \tau_j} = ? (< 0)^7$	-	-	-	-	-	-	$< 0^6$	$= 0$	$< 0^{5,7}$	$= 0$

Notes: Following assumptions were considered by deriving the comparative statics: ¹ convexity of $g^*(.)$ in X_l^h ; ² concavity of $f^*(.)$ in X_l^s ; ³ concavity of $\Pi(.)$ in $p_i (i \in PG)$; ⁴ X_v and X_l are complements; ⁵ convexity of $e(.)$ in $p_i (i \in CG)$; ⁶ C_a, C_m and C_l are normal goods; ⁷ C_a are substitutes for C_l .

Table 4: Comparative statics for input tax in non-separable model

$\tau_j = \tau_{vat}$		Direct tax-induced labor market reactions		Direct effect from tax-induced price changes of PG			Indirect effect on PG	Direct income effect	Direct substitution effect from price changes of CG		Indirect effect on CG
		X_l^h	X_l^s	p_{Pc}^*	p_{Pa}^*	p_{Pv}^*			p_{Cm}^*	p_{Ca}^*	
$\frac{\partial Z_i}{\partial \tau_j}$		$\left. \frac{\partial X_l^h}{\partial \tau_j} \right _{p_i^* = const}$	$\left. \frac{\partial X_l^s}{\partial \tau_j} \right _{p_i^* = const}$	$\frac{\partial X_i}{\partial p_{Pc}^*} \frac{\partial p_{Pc}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pa}^*} \frac{\partial p_{Pa}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pv}^*} \frac{\partial p_{Pv}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial Y} \Psi$	$\frac{\partial C_i}{\partial p_{Cm}^*} \frac{\partial p_{Cm}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_{Ca}^*} \frac{\partial p_{Ca}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$
Shadow price	$\frac{\partial P_l^*}{\partial \tau_j} = ?$	= 0	= 0	= 0	= 0	$(> 0^4)^3$	-	$< 0^{5,6}$	$(> 0^7)^5$	= 0	-
Labor market responses	$\frac{\partial X_l^h}{\partial \tau_j} = ?$	= 0	-	-	-	-	?	-	-	-	-
	$\frac{\partial X_l^s}{\partial \tau_j} = ?$	-	= 0	-	-	-	?	-	-	-	-
Production responses	$\frac{\partial X_{c,a}}{\partial \tau_j} = ?$	-	-	= 0	= 0	$< 0^3$?	-	-	-	-
	$\frac{\partial X_v}{\partial \tau_j} = ?$	-	-	= 0	= 0	$< 0^3$?	-	-	-	-
	$\frac{\partial X_l}{\partial \tau_j} = ?$	-	-	= 0	= 0	$(> 0^4)^3$?	-	-	-	-
Consumption responses	$\frac{\partial C_m}{\partial \tau_j} = ?$	-	-	-	-	-	-	$< 0^6$	= 0	= 0	?
	$\frac{\partial C_a}{\partial \tau_j} = ?$	-	-	-	-	-	-	$< 0^6$	= 0	= 0	?
	$\frac{\partial C_l}{\partial \tau_j} = ?$	-	-	-	-	-	-	$< 0^6$	= 0	= 0	?

Table 4a: Comparative statics for input tax in separable model

$\tau_j = \tau_{vat}$		Direct tax-induced labor market reactions		Direct effect from tax-induced price changes of PG				Direct income effect	Direct substitution effect from price changes of CG		
		X_l^h	X_l^s	p_{Pc}^*	p_{Pa}^*	p_{Pv}^*	p_l^*		p_{Cm}^*	p_{Ca}^*	p_l^*
$\frac{\partial Z_i}{\partial \tau_j}$		$\left. \frac{\partial X_l^h}{\partial \tau_j} \right _{p_i^* = const}$	$\left. \frac{\partial X_l^s}{\partial \tau_j} \right _{p_i^* = const}$	$\frac{\partial X_i}{\partial p_{Pc}^*} \frac{\partial p_{Pc}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pa}^*} \frac{\partial p_{Pa}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pv}^*} \frac{\partial p_{Pv}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial Y} \Psi$	$\frac{\partial C_i}{\partial p_{Cm}^*} \frac{\partial p_{Cm}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_{Ca}^*} \frac{\partial p_{Ca}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$
Labor market	$\frac{\partial (X_l^s - X_l^h)}{\partial \tau_j} (> 0^4)$	-	-	= 0	= 0	(> 0^4)^3	= 0	< 0^6	= 0	= 0	= 0
Production responses	$\frac{\partial X_{c,a}}{\partial \tau_j} = 0$	-	-	= 0	= 0	< 0^3	= 0	-	-	-	-
	$\frac{\partial X_v}{\partial \tau_j} = 0$	-	-	= 0	= 0	< 0^3	= 0	-	-	-	-
	$\frac{\partial X_l}{\partial \tau_j} = 0$	-	-	= 0	= 0	(> 0^4)^3	= 0	-	-	-	-
Consumption responses	$\frac{\partial C_m}{\partial \tau_j} < 0$	-	-	-	-	-	-	< 0^6	= 0	= 0	= 0
	$\frac{\partial C_a}{\partial \tau_j} = ?$	-	-	-	-	-	-	< 0^6	= 0	= 0	= 0
	$\frac{\partial C_l}{\partial \tau_j} = ?$	-	-	-	-	-	-	< 0^6	= 0	= 0	= 0

Notes: Following assumptions were considered by deriving the comparative statics: ¹ convexity of $g^*(.)$ in X_l^h ; ² concavity of $f^*(.)$ in X_l^s ; ³ concavity of $\Pi(.)$ in $p_i (i \in PG)$; ⁴ X_v and X_l are complements; ⁵ convexity of $e(.)$ in $p_i (i \in CG)$; ⁶ C_a, C_m and C_l are normal goods; ⁷ C_a are substitutes for C_l .

Table 5: Comparative statics for land tax in non-separable model

$\tau_j = \tau_G$		Direct tax-induced labor market reactions		Direct effect from tax-induced price changes of PG			Indirect effect on PG	Direct income effect	Direct substitution effect from price changes of CG		Indirect effect on CG
		X_l^h	X_l^s	p_{Pc}^*	p_{Pa}^*	p_{Pv}^*			p_{Cm}^*	p_{Ca}^*	
$\frac{\partial Z_i}{\partial \tau_j}$		$\left. \frac{\partial X_l^h}{\partial \tau_j} \right _{P_l^* = const}$	$\left. \frac{\partial X_l^s}{\partial \tau_j} \right _{P_l^* = const}$	$\frac{\partial X_i}{\partial p_{Pc}^*} \frac{\partial p_{Pc}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pa}^*} \frac{\partial p_{Pa}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pv}^*} \frac{\partial p_{Pv}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial Y} \Psi$	$\frac{\partial C_i}{\partial p_{Cm}^*} \frac{\partial p_{Cm}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_{Ca}^*} \frac{\partial p_{Ca}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$
Shadow price	$\frac{\partial P_l^*}{\partial \tau_j} < 0$	= 0	= 0	= 0	= 0	= 0	-	< 0 ^{5,6}	= 0	= 0	-
Labor market responses	$\frac{\partial X_l^h}{\partial \tau_j} < 0$	= 0	-	-	-	-	< 0 ¹	-	-	-	-
	$\frac{\partial X_l^s}{\partial \tau_j} > 0$	-	= 0	-	-	-	> 0 ²	-	-	-	-
Production responses	$\frac{\partial X_{c,a}}{\partial \tau_j} > 0$	-	-	= 0	= 0	= 0	> 0 ³	-	-	-	-
	$\frac{\partial X_v}{\partial \tau_j} (> 0^4)$	-	-	= 0	= 0	= 0	(> 0 ⁴) ³	-	-	-	-
	$\frac{\partial X_l}{\partial \tau_j} > 0$	-	-	= 0	= 0	= 0	> 0 ³	-	-	-	-
Consumption responses	$\frac{\partial C_m}{\partial \tau_j} (< 0^7)$	-	-	-	-	-	-	< 0 ⁶	= 0	= 0	(< 0 ⁷) ⁵
	$\frac{\partial C_a}{\partial \tau_j} (< 0^7)$	-	-	-	-	-	-	< 0 ⁶	= 0	= 0	(< 0 ⁷) ⁵
	$\frac{\partial C_l}{\partial \tau_j} = ?$	-	-	-	-	-	-	< 0 ⁶	= 0	= 0	> 0

Table 5a: Comparative statics for land tax in separable model

$\tau_j = \tau_G$		Direct tax-induced labor market reactions		Direct effect from tax-induced price changes of PG				Direct income effect	Direct substitution effect from price changes of CG		
		X_l^h	X_l^s	p_{pc}^*	p_{pa}^*	p_{pv}^*	p_l^*		p_{cm}^*	p_{ca}^*	p_l^*
$\frac{\partial Z_i}{\partial \tau_j}$		$\left. \frac{\partial X_l^h}{\partial \tau_j} \right _{p_i^* = const}$	$\left. \frac{\partial X_l^s}{\partial \tau_j} \right _{p_i^* = const}$	$\frac{\partial X_i}{\partial p_{pc}^*} \frac{\partial p_{pc}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{pa}^*} \frac{\partial p_{pa}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{pv}^*} \frac{\partial p_{pv}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial Y} \Psi$	$\frac{\partial C_i}{\partial p_{cm}^*} \frac{\partial p_{cm}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_{ca}^*} \frac{\partial p_{ca}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$
Labor market	$\frac{\partial (X_l^s - X_l^i)}{\partial \tau_j} > 0$	-	-	= 0	= 0	= 0	= 0	< 0 ⁶	= 0	= 0	= 0
Production responses	$\frac{\partial X_{c,a}}{\partial \tau_j} = 0$	-	-	= 0	= 0	= 0	= 0	-	-	-	-
	$\frac{\partial X_v}{\partial \tau_j} = 0$	-	-	= 0	= 0	= 0	= 0	-	-	-	-
	$\frac{\partial X_l}{\partial \tau_j} = 0$	-	-	= 0	= 0	= 0	= 0	-	-	-	-
Consumption responses	$\frac{\partial C_m}{\partial \tau_j} < 0$	-	-	-	-	-	-	< 0 ⁶	= 0	= 0	= 0
	$\frac{\partial C_a}{\partial \tau_j} < 0$	-	-	-	-	-	-	< 0 ⁶	= 0	= 0	= 0
	$\frac{\partial C_l}{\partial \tau_j} < 0$	-	-	-	-	-	-	< 0 ⁶	= 0	= 0	= 0

Notes: Following assumptions were considered by deriving the comparative statics: ¹ convexity of $g^*(.)$ in X_l^h ; ² concavity of $f^*(.)$ in X_l^s ; ³ concavity of $\Pi(.)$ in $p_i (i \in PG)$; ⁴ X_v and X_l are complements; ⁵ convexity of $e(.)$ in $p_i (i \in CG)$; ⁶ C_a, C_m and C_l are normal goods; ⁷ C_a are substitutes for C_l .

Table 6: Comparative statics for value added tax in non-separable model

$\tau_j = \tau_{vat}$		Direct tax-induced labor market reactions		Direct effect from tax-induced price changes of PG			Indirect effect on PG	Direct income effect	Direct substitution effect from price changes of CG		Indirect effect on CG
		X_l^h	X_l^s	p_{Pc}^*	p_{Pa}^*	p_{Pv}^*			p_{Cm}^*	p_{Ca}^*	
$\frac{\partial Z_i}{\partial \tau_j}$		$\left. \frac{\partial X_l^h}{\partial \tau_j} \right _{p_l^* = const}$	$\left. \frac{\partial X_l^s}{\partial \tau_j} \right _{p_l^* = const}$	$\frac{\partial X_i}{\partial p_{Pc}^*} \frac{\partial p_{Pc}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pa}^*} \frac{\partial p_{Pa}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pv}^*} \frac{\partial p_{Pv}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial Y} \Psi$	$\frac{\partial C_i}{\partial p_{Cm}^*} \frac{\partial p_{Cm}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_{Ca}^*} \frac{\partial p_{Ca}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$
Shadow price	$\frac{\partial P_l^*}{\partial \tau_j} = ?$	= 0	= 0	= 0	= 0	= 0	-	< 0 ^{5,6}	(> 0 ⁷) ⁵	= 0	-
Labor market responses	$\frac{\partial X_l^h}{\partial \tau_j} = ?$	= 0	-	-	-	-	?	-	-	-	-
	$\frac{\partial X_l^s}{\partial \tau_j} = ?$	-	= 0	-	-	-	?	-	-	-	-
Production responses	$\frac{\partial X_{c,a}}{\partial \tau_j} = ?$	-	-	= 0	= 0	= 0	?	-	-	-	-
	$\frac{\partial X_v}{\partial \tau_j} = ?$	-	-	= 0	= 0	= 0	?	-	-	-	-
	$\frac{\partial X_l}{\partial \tau_j} = ?$	-	-	= 0	= 0	= 0	?	-	-	-	-
Consumption responses	$\frac{\partial C_m}{\partial \tau_j} = ?$	-	-	-	-	-	-	< 0 ⁶	< 0 ⁵	= 0	?
	$\frac{\partial C_a}{\partial \tau_j} = ?$	-	-	-	-	-	-	< 0 ⁶	(> 0 ⁷) ⁵	= 0	?
	$\frac{\partial C_l}{\partial \tau_j} = ?$	-	-	-	-	-	-	< 0 ⁶	(> 0 ⁷) ⁵	= 0	?

Table 6a: Comparative statics for value added tax in separable model

$\tau_j = \tau_{vat}$		Direct tax-induced labor market reactions		Direct effect from tax-induced price changes of PG				Direct income effect	Direct substitution effect from price changes of CG		
		X_l^h	X_l^s	p_{Pc}^*	p_{Pa}^*	p_{Pv}^*	p_l^*		p_{Cm}^*	p_{Ca}^*	p_l^*
$\frac{\partial Z_i}{\partial \tau_j}$		$\left. \frac{\partial X_l^h}{\partial \tau_j} \right _{p_l^* = const}$	$\left. \frac{\partial X_l^s}{\partial \tau_j} \right _{p_l^* = const}$	$\frac{\partial X_i}{\partial p_{Pc}^*} \frac{\partial p_{Pc}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pa}^*} \frac{\partial p_{Pa}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_{Pv}^*} \frac{\partial p_{Pv}^*}{\partial \tau_j}$	$\frac{\partial X_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial Y} \Psi$	$\frac{\partial C_i}{\partial p_{Cm}^*} \frac{\partial p_{Cm}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_{Ca}^*} \frac{\partial p_{Ca}^*}{\partial \tau_j}$	$\frac{\partial C_i}{\partial p_l^*} \frac{\partial p_l^*}{\partial \tau_j}$
Labor market	$\frac{\partial (X_l^s - X_l^h)}{\partial \tau_j} = ?$	-	-	= 0	= 0	= 0	= 0	< 0 ⁶	(> 0 ⁷) ⁵	= 0	= 0
Production responses	$\frac{\partial X_{c,a}}{\partial \tau_j} = 0$	-	-	= 0	= 0	= 0	= 0	-	-	-	-
	$\frac{\partial X_v}{\partial \tau_j} = 0$	-	-	= 0	= 0	= 0	= 0	-	-	-	-
	$\frac{\partial X_l}{\partial \tau_j} = 0$	-	-	= 0	= 0	= 0	= 0	-	-	-	-
Consumption responses	$\frac{\partial C_m}{\partial \tau_j} < 0$	-	-	-	-	-	-	< 0 ⁶	< 0 ⁵	= 0	= 0
	$\frac{\partial C_a}{\partial \tau_j} = ?$	-	-	-	-	-	-	< 0 ⁶	(> 0 ⁷) ⁵	= 0	= 0
	$\frac{\partial C_l}{\partial \tau_j} = ?$	-	-	-	-	-	-	< 0 ⁶	(> 0 ⁷) ⁵	= 0	= 0

Notes: Following assumptions were considered by deriving the comparative statics: ¹ convexity of $g^*(.)$ in X_l^h ; ² concavity of $f^*(.)$ in X_l^s ; ³ concavity of $\Pi(.)$ in $p_i (i \in PG)$; ⁴ X_v and X_l are complements; ⁵ convexity of $e(.)$ in $p_i (i \in CG)$; ⁶ C_a, C_m and C_l are normal goods; ⁷ C_a are substitutes for C_l .