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Tax policies and the labor market constrained farm household: Theoretical results and evidence from household data

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Abstract: The study is devoted to the comparative static analysis and econometric estimation of farm household decisions under both standard and agricultural taxes. To account for labor markets constraints a non-separable model is constructed implying increasing per-unit costs of accessing labor markets. 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. Theoretical results suggest that most tax-induced responses are ambivalent mainly caused by shadow prices effects. Further, tax-induced effects differ between the two model versions. In particular standard taxes may imply production adjustments in the case of non-separability. Thus, income and value-added taxes are no more necessarily superior to agricultural taxes. Econometric analysis using individual household data from Mid-West Poland indicates remarkable responses to market surplus and input taxes. In contrast, standard and land taxes imply only negligible production adjustments. Thus, they seem to be superior, at least in the Polish case.

Keywords: tax policies, farm household, estimation

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Introduction

There are at least two good reasons why taxation of agricultural households deserves special study and cannot simply be treated as a standard taxation problem of non-peasant economies. First, in many countries, especially in developing and transition economies, the use of both standard tax tools, value added and income taxes, is limited. It is often costly to tax transactions between producers and consumers by a value added tax, especially the farm household or in informal markets. Furthermore, difficulties in observing a household's annual income restrict the implementation of a well-defined income tax scheme (Ahmad and Stern; Newbery).¹ Second, tax-induced farm household decisions may be reflected inadequately by conventional household and firm approaches, dichotomizing consumption and production decisions. In particular, when related markets are imperfectly competitive, production organization and consumption choice are jointly determined (Strauss).

Extensive literature refers to the identification of feasible taxation tools for peasants' 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; Rao; Burgess and Stern). In addition, some papers investigate the analysis of tax-induced allocation and distribution effects within partial equilibrium frameworks (Atkinson) and dual-economy approaches (Sah and Stiglitz), as well as the application of optimal taxation models to peasant economies (Heady and Mitra; Stiglitz and Dasgupta; Munk). In contrast, studies focusing on the rigorous derivation of farm household decisions to tax policies are rare. Ahmad and Stern examine the farm household effects of several agricultural tax tools (marked surplus, gross output, and input taxes) within a simplified theoretical farm household approach. Chambers and Lopez analyze the implications of standard taxes (income, profit, and consumption taxes) on financially constrained farm households within a dynamic approach. Lopez considers several income tax brackets by the estimation of farm household decisions, but does not explicitly examine their implications on consumption and production decisions.

This study is devoted to the theoretical analysis and empirical estimation of farm household decisions under both standard and agricultural taxes, assuming labor markets are imperfect². Binding hours constraints in off-farm employment may prevent a complete adjustment in agricultural labor markets (Benjamin). Family and hired labor may be imperfect substitutes in agricultural production (Deolalikar and Vijverberg; Jakoby). Also, farmers may have preferences towards working on or off the farm (Lopez). In addition, costs associated with labor market transaction, can explain why households have different relationships to the labor markets (Sadoulet, de Janvry and Benjamin).

To account for imperfect labor markets, a non-separable farm household model is constructed. 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. Thus, the relevant wage rate is endogenously determined. The advantage of this methodology is twofold. First, the model accounts for several kinds of labor market imperfections, notably institutional restrictions (e.g. binding hours 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, the differs from former

¹ Diamond and Mirrless point out that problems arise with models considering taxation of all transactions, but in fact some transactions may not be taxable. They explicitly refer to subsistence agriculture, where in particular transactions with consumers are hard to tax.

² Newbery argues that the incidence of agricultural taxes is different from that of standard taxes, and will depend on the way the labor markets operate.

approaches, which assume either a completely absent labor market or an exogenously fixed rationing of off-farm employment. Second, the approach is applicable for various labor market regimes, including the cases in which farms simultaneously hire on-farm labor and sell off-farm labor.

We investigate the comparative static to compare production, consumption and labor market effects caused by alternative tax policies. In detail, we analyze an income and value-added tax, the main standard tax tools, as well as an off-farm income tax ('wage tax') and several agricultural taxes (marked 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 at least examine basic rules regarding the optimality of the tax tools under consideration, at least from the efficiency point of view.³ 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 seems to be interesting whether this ranking holds when labor markets are constrained.

The econometric analysis is based on a full-specified non-separable farm household model and relies on individual household data from several regions in Mid-West Poland (1991-1994). Based on the estimated parameters we derive 'tax elasticities' capturing the direction and extent of tax-induced consumption, production, and labor market reactions. We compare the results with tax elasticities assuming separability.

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; Fafchamps) and credit constraints (Chambers and Lopez; de Janvry et al.). The model framework can cover both the case of imperfect and, with few rearrangements, perfect labor markets. The farm household is assumed to maximize utility derived from consumption and leisure subject to a technology constraint (2), a time constraint (3), and a 'tax-corrected' budget constraint (4). Therefore, farm households solve the following maximization problem:

$$(1) \quad \max_{x,c} U(c)$$

subject to

$$(2) \quad G(x,r) = 0$$

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

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

Here $U(c)$ is the farm household's utility function, which is assumed to be monotonically increasing and strictly concave. c is a vector of consumption goods consisting of market commodities (C_m), self-produced agricultural goods (C_a), and leisure (C_l).

³ In their fundamental work, Diamond and Mirrless argue that production efficiency is desirable within an optimal taxation system, even if a full Pareto optimum is not archived. 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.

Production technology (2) is represented by a multi-output, multi-input production function ($G(x,r)=0$), which is assumed to be well behaved in the usual sense (Lau). Here $x \in PG$ is a vector of production goods, expressed as netputs, and r is a vector of quasi-fixed factors. The farm household is assumed to produce market (X_c) and home-consumed (X_a) agricultural goods using commercial Inputs (X_v), labor (X_l), and the quasi-fixed factors land and capital.

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, farmers neither sell nor hire labor (autarky). Third and fourth, they either sell or hire labor. Note that when labor markets are perfectly competitive, farm households will likely either sell or hire labor.

Farm household budget constraint⁴ (4) states that a household's gross of tax expenditures (left-hand side of (4)) must not exceed its total net of tax income (right-hand side). Households' may receive income from farming and from off-farm employment. In addition, it receives or pays transfers (E)⁵ which are determined exogenously. Here, $P_i; i = m, a, c, v$ denote the exogenous consumer and producer prices before tax and $(1-\tau_j); j = y, ms, ls, (1+\tau_j); j = vat, v$, and τ_r , where $\tau_j \in [0,1]$, are the parameters of tax policies to be analyzed. Note that all taxes to be considered here should be interpreted as alternative tax policies.

In detail, $(1+\tau_{vat})$ denotes the coefficient of the value-added tax. Legally and in non-peasant households, total monetary expenditures are subject to value-added taxes. For farm households, however, internal transfer of self-produced agricultural goods cannot be observed by tax authorities. Thus, only the expenditures for market commodities ($P_m C_m$) are subject to the value-added tax. The basis of the income tax $(1-\tau_y)$ is household's total 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), as well as 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 $(1-\tau_w)$. Similarly, market surplus, input, or land taxes are applied as surrogates for an income tax. The base of the market surplus tax $(1-\tau_{ms})$ 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 of the input tax $(1-\tau_v)$ and the market value of land is taxed by a land tax $(\tau_r R)$.

⁴ To analyze the impact of the market surplus (t_{ms}) and value-added taxes (t_{vat}), it becomes necessary to differentiate between net sellers and net buyers of the self-produced agricultural goods. In particular, due to the empirical evidence in our data base, we suppose that the household is a net supplier ($X_a - C_a > 0$).

⁵ If $E > 0$ ($E < 0$) then the household receives (pays) transfers.

To consider labor market imperfections, revenues from off-farm employment and hired labor costs are conceptualized as functions of supplied $f(X_i^s)$ and hired $g(X_i^h)$ labor time. If perfectly competitive labor markets are to be assumed, then the functions are both linear, with $\partial f(\cdot)/\partial X_i^s = P_l$ or $\partial g(\cdot)/\partial X_i^h = P_l$. Hence, marginal off-farm income or marginal costs for hired labor are equal to the exogenously given wage rate (P_l). In this case, the farm household model is separable (between production and household decisions).

In contrast, when labor markets are assumed to be imperfectly competitive both functions become nonlinear with the following properties: $\partial f(\cdot)/\partial X_i^s > 0$; $\partial^2 f(\cdot)/\partial X_i^{s^2} < 0$ and $\partial g(\cdot)/\partial X_i^h > 0$; $\partial^2 g(\cdot)/\partial X_i^{h^2} > 0$, 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 for 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 argued before (see ‘Introduction’), this framework is applicable for several kinds of labor market imperfections. In particular, it accounts for labor market imperfections which 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-units costs of accessing labor markets, or in other words as increasing transaction costs.

Increasing transaction costs associated with working off the farm may be caused by an increasing heterogeneity between on- and off-farm family labor. With a growing migration household members are first transferring to the ‘best jobs’ followed by the ‘next best jobs’ and so on (Low 1982, 1986). Similarly, 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. It seems to be more and more difficult to find the ‘right’ staff for the different and often farm-specific areas of production. Moreover, with increasing staff and hired labor time, respectively, the supervision and monitoring per-unit of hired labor may become more costly⁶. 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.

Note that the approach could additionally incorporate fixed costs of transactions that are invariant to the traded quantity⁷, but also could affect the farm household’s decision to participate in markets (Sadoulet, de Janvry and Benjamin for the labor markets; Goetz as well as Key, Sadoulet and de Janvry for food markets; Skoufias 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.

Taking fixed costs of accessing labor markets into account might mainly contribute to the explanation of the different labor market participation regimes: hiring on-farm and supplying off-farm labor simultaneously, autarky, either hiring on-farm or selling off-farm

⁶ Key, Sadoulet and de Janvry (2000) state in contrast that search and supervision activities are independent from the quantity of hired labor.

⁷ If fixed transaction cost are explicitly considered, it follows that $\tilde{f}(X_i^s) = f(X_i^s) - \kappa_s$ and $\tilde{g}(X_i^h) = g(X_i^h) + \kappa_h$, where the household pays the fixed costs κ_s if and only if it sells off-farm labor, and pays κ_h if and only if it hires on-farm labor.

labor. This paper does not investigate the analysis of different market participation regimes and thus we do not explicitly model fixed transaction costs within the theoretical framework. We assume that the farm household hires on-farm and supplies off-farm labor simultaneously. Without any problems, the model is applicable for all other market participation schemes by simply ‘ignoring’ the respective labor market function. In contrast, within the empirical analysis the possible occurrence of fixed cost in accessing the labor market is taken into account, in particular to identify the ‘true’ labor market conditions.

The stationary solutions to the maximization problem (1)-(4) determine the optimal quantities of consumption and production goods, and the allocation of time, assuming there exists an interior solution ($\lambda, \phi, \mu > 0$ and $c, x > 0$).

$$(5) \quad U_i(.) - \lambda P_i^* = 0 \quad i \in \{m, a, l\}$$

$$(6) \quad \phi G_i(.) + \lambda P_i^* = 0 \quad i \in \{c, a, v, l\}$$

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

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

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

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

Here $\lambda, \phi > 0$ are 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, where μ is the Lagrangian multiplier associated with the time constraint. In the separable version, P_l^* indicates the exogenous net of tax wage rate. Furthermore, $P_{Cm}^* = (1 + \tau_{vat})P_m$ and $P_{Ca}^* = (1 - \tau_{ms})P_a$ represent the (‘tax-corrected’) decision prices for consumption goods. The decision prices for production goods are indicated by $P_{Pc}^* = (1 - \tau_y)(1 - \tau_{ms})P_c$, $P_{Pa}^* = (1 - \tau_y)(1 - \tau_{ms})P_a$ and $P_{Pv}^* = (1 - \tau_y)(1 + \tau_v)P_v$. In addition, the following definitions hold: $R^* = \tau_r R$, $f^*(.) = (1 - \tau_y)(1 - \tau_{ls})f(.)$, and $g^*(.) = (1 - \tau_y)g(.)$.

Comparative Statics

To facilitate the comparative static analysis we transform the primal decision problem (1)-(4) into a dual representation (Diewert). 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 $\Pi(p_p^*, r) = \sum_{i \in PG} P_{Pi}^* X_i$ is the optimum profit. Following Hotelling’s lemma, the optimal quantities of production goods are defined by $\partial \Pi(.) / \partial P_i^* = \Pi_i(p_p^*, r); \forall i \in \{c, a, v, l\}$.

Further, we can define a dual expenditure function $e(p_c^*, U^o) \equiv \min_c \{p_c^* c \mid U(c) \geq U^o\}$. Here p_c^* is the (decision) price vector of the consumption goods and U^o is the (optimal) utility level. According to Shepard’s lemma, we can derive the hicksian compensated demand

function, with $\partial e(\cdot)/\partial P_i = e_i(p_C^*, U^\circ); \forall i \in \{m, a, l\}$. Substituting U° by the indirect utility function $V(p_C^*, Y)$, it holds that $e_i(p_C^*, V(p_C^*, Y)) \equiv e_i^M(p_C^*, Y)$. 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 $X_l^s = s(P_l^*, \tau_j)$ and the demand for hired labor $X_l^h = h(P_l^*, \tau_j)$ as implicit functions of the endogenous labor price (P_l^*) and of those tax parameters (τ_y, τ_w) that (directly) affect the general loan level and hence the position of the labor market functions⁸.

Substituting the defined dual and implicit functions into the time constraint (10) results in:

$$(11) \quad T_l + \Pi_l(p_p^*, r) + h(P_l^*, \tau_j) - s(P_l^*, \tau_j) - e_l^M(p_C^*, Y) = 0,$$

$$\text{where } Y = \Pi(\cdot) - g^* \circ h(\cdot) + f^* \circ s(\cdot) + P_l^*(T_l + h(\cdot) - s(\cdot)) - R^* + E = \sum_{i \in CG} P_{Ci}^* C_i.$$

Equation (11) implicitly defines the shadow wage (P_l^*) around the optimal solution of the non-separable model. Hence, $P_l^* = \chi(p_C^*, p_p^*, r, T_l, E, R^*, \tau_j)$ is an implicit function of exogenous decision prices for consumption and production goods (p_C^* and p_p^*), fixed resources (r), total time available (T_l), land tax payments (R^*), 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 to the shadow price is already reflected by ‘tax-corrected’ exogenous prices (p_C^*, p_p^*).

Based on the above defined functions, we can derive farm households’ consumption, production and labor market responses ($Z = C_i, X_i, X_l^s, X_l^h$) to changes in any of the designed 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 reactions for any arbitrary tax policy into the following two components (de Janvry et al.; Sonoda and Maruyama):

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

The first term (direct component) on the right-hand side represents the supply or demand reactions to changes in the designed 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 version, we have to derive the tax-induced shadow price adjustment from equation (11), applying the implicit function theorem (de Janvry et al.):

⁸ 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 $f^*(\cdot) = (1 - \tau_w)f(\cdot)$.

$$(13) \quad P_{l\tau_j}^* = \frac{\partial P_l^*}{\partial \tau_j} = - \frac{(\Pi_{l\tau_j} + h_{\tau_j} - s_{\tau_j} - e_{l\tau_j}) - (e_{lY}^M \Psi)}{(\Pi_{ll} + h_l - s_l - e_{ll})}.$$

The numerator on the right-hand side represents the direct tax-induced farm household effects. Here, $\Pi_{l\tau_j} = \sum_{i \in \{c, a, v\}} \frac{\partial X_l}{\partial P_i^*} \frac{\partial P_i^*}{\partial \tau_j}$ denotes tax-induced on-farm labor adjustment, and $h_{\tau_j} = (\partial X_l^h / \partial \tau_j) \Big|_{P_i^* = \text{const.}}$ and $s_{\tau_j} = (\partial X_l^s / \partial \tau_j) \Big|_{P_i^* = \text{const.}}$ are the direct labor market reactions to increasing income or wage taxes⁹. Furthermore, $e_{l\tau_j} = \sum_{i \in \{m, a\}} \frac{\partial C_l}{\partial P_i^*} \frac{\partial P_i^*}{\partial \tau_j} \Big|_{Y = \text{const.}}$ and $e_{lY}^M \Psi = (\partial C_l / \partial Y) \Psi$ are the tax-induced substitution and income effects with regard to the demand of leisure. Here, $\Psi = \partial Y / \partial \tau_j = \sum_{i \in \{c, a, v\}} X_i \frac{P_i^*}{\partial \tau_j} - \frac{\partial}{\partial \tau_j} (g^* + f^* - R^*) - \sum_{i \in \{m, a\}} C_i \frac{P_i^*}{\partial \tau_j}$ reflects the income change.

The denominator indicates the change in the time allocation caused by changes in the internal wage rate. Here, $\Pi_{ll} = \partial X_l / \partial P_l^* > 0$, $h_l = \partial X_l^h / \partial P_l^* = 1 / (\partial^2 g^*(\cdot) / \partial X_l^{h^2}) > 0$, $s_l = \partial X_l^s / \partial P_l^* = 1 / (\partial^2 f^*(\cdot) / \partial X_l^{s^2}) < 0$ and $e_{ll} = \partial C_l / \partial P_l^* < 0$ ¹⁰. Note that the denominator is always positive given convexity of $\Pi(\cdot)$ and the concavity of $e(\cdot)$ in prices, and given the convexity of $g^*(\cdot)$ and the concavity of $f^*(\cdot)$ in traded labor.

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

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

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

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

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

Equation (14) indicates the tax-induced production adjustments, where $\Pi_{i\tau_j} = \sum_{k \in \{c, a, v\}} \frac{\partial X_i}{\partial P_k^*} \frac{\partial P_k^*}{\partial \tau_j}$; $i = \{c, a, v, l\}$ denotes the respective direct component and $\Pi_{il} P_{l\tau_j}^* = \frac{\partial X_i}{\partial P_l^*} \frac{\partial P_l^*}{\partial \tau_j}$, $i = \{c, a, v, l\}$ is the indirect component. Equation (15) represents

⁹ As noted before, direct labor market reactions result only for an income and a wage tax, since only these taxes directly affect the general loan level. Thus, the following direct tax-induced labor market reactions result:

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

¹⁰ 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 (de Janvry et al. 1992)

households' consumption responses, where $e_{i\tau_j} = \sum_{k \in \{m,a\}} \frac{\partial C_i}{\partial P_k^*} \frac{\partial P_k^*}{\partial \tau_j} \Big|_{Y=const.}$ and

$e_{iY}^M \Psi = \frac{\partial C_i}{\partial Y} \frac{\partial Y}{\partial \tau_j}; i = \{m, a, l\}$ are the tax-induced direct substitution and income effects, and

$e_{iP_l^*} = \frac{\partial C_i}{\partial P_l^*} \frac{\partial P_l^*}{\partial \tau_j}; i = \{m, a, l\}$ denotes the corresponding indirect component. The last two

equations (16) and (17) represent farm households adjustments regarding the supply of family labor off-farm and the demand for hired labor, respectively. Here, the respective first terms (right-hand side) are direct tax-induced adjustments, whereby the second terms indicate the respective indirect components (see above).

Assuming separability, in most cases farm households' economical 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 ($\tau_j | j = ms, v, r, vat$) which do not affect the general loan level. In contrast, they do not coincide with the direct components of the separable version in the case of a increasing income or wage tax ($\tau_j | j = y, w$) since both directly affect the general wage level and hence the position of the labor market functions. Regarding the labor markets, comparative statics of the separable version differ from the direct component of the non-separable version for all tax policies under consideration. In the case of separability, labor market adjustments residually result from the time constrained, after production and consumption decisions are made: $\partial(T_l + X_l - C_l)/\partial \tau_j$.

In accordance with the equations (13) to (17), we derive the complete comparative static for all tax instruments mentioned above, summarized in the following sections¹¹. In particular, we compare the tax-induced adjustments within the non-separable version with those of the separable framework. Since all designed tax policies have to be interpreted as alternative tax instruments, it is assumed that the respective tax under consideration is the only tax policy applied to the farm household.

Income tax

In the case of non-separability, an increase in the income tax results directly in a proportional decrease of all exogenous production prices $P_k^*; k = \{c, a, v\}$ ¹². This leads to a decrease in both output supply and on-farm labor demand. The demand for commercial intermediates will decrease (increase) assuming they are complements (substitutes) to labor. In contrast, because an increasing income tax implies a falling internal wage rate, the indirect component supports just the opposite adjustments. Since the internal wage likely does not decrease in the same proportion as the other production prices production responses to income taxes are probable, but theoretically ambivalent. If the labor markets are assumed to be 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. Obviously, production effects do not simply coincide with the direct component within the non-separable approach.

¹¹ On request, a detailed documentation of the comparative static is available from the authors.

¹² Falling exogenous production prices enforce the same production adjustments as an increasing price for labor.

Strictly speaking, tax-induced consumption reactions are also theoretically unclear within the non-separable framework. If the income effects (direct component) dictate the total effects, then the household reduces the consumption of all goods¹³. If the indirect shadow price component is predominant, then the leisure demand increases while the consumption of market and self-produced goods decreases.¹⁴ 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 ambivalent. While the direct component implicates 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. 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 implicates a decrease in off-farm labor, and the income effect results in the opposite. The contrary holds, assuming farmers hire on-farm labor.

Wage tax

Assuming imperfectly competitive labor markets, a wage tax has no direct impact on farmers' production decisions. However, a wage tax leads to a reduction in the internal valuation of labor, inducing farmers to raise output supply and on-farm labor. Regarding consumption and off-farm labor adjustments, a wage tax causes similar theoretical effects as a income tax, probably not in extent 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 employment¹⁵ 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. 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 production and hicksian substitution effects reduce the tendency to work off-farm, the income effect supports the opposite.¹⁶

¹³ As long as the goods are not inferior.

¹⁴ Assuming substitutive relationships in consumption.

¹⁵ In general, an imposition of a wage tax leads in the separable model version to differences ($P_i^{s*} < P_i^{h*}$)

between the exogenous price for hired labor (P_i^{h*}) and the exogenous price for off-farm labor (P_i^{s*}). 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.

¹⁶ Similar to the income tax, the comparative static of the separable model does not coincide with the direct component of the non-separable framework at all.

Market surplus tax

Similar to both tax policies mentioned above, production and consumption adjustments, are theoretically ambivalent. An increasing market surplus tax reduces the output prices, and leads via direct component to a reduction in production activities. Assuming a decreasing internal wage¹⁷, the indirect component affects production in approximately the opposite direction. Furthermore, the tax-induced lower consumption value of the self-produced commodity, causes via hicksian net-substitution reactions an higher (lower) demand of these self-produced goods (market goods and leisure). The indirect shadow price component leads to adjustments just in the opposite direction. Because of these counteracting effects, a predominance of the direct income effect that reduces the demand for all goods appears to be probable. 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.

Assuming separability, tax-induced production and consumption reactions coincide with the respective direct components of the non-separable framework. That is, production and consumption will be reduced. Furthermore, the adjustment regarding the labor markets follows in the same direction as in the case of non-separability. The farm household either increases the off-farm employment or demands less hired labor.

Input tax

An increasing input tax implies an higher exogenous (decision) price of commercial inputs, which leads to an ambivalent adjustment of the internal wage rate¹⁸. Not least because of the undermined change of the internal wage, production and consumption responses are theoretically unclear.

The higher price for commercial inputs causes via the direct component a lower output supply and demand for commercial inputs and on-farm labor¹⁹. 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 implicates via the negative direct income effect a general reduction in consumption. However, a reduced (increased) internal wage rate leads to a higher (lower) leisure demand. Similarly the market surplus tax, in the case of a decreased internal wage an input tax leads to an additional off-farm labor supply and a reduction of hired labor. However, the opposite reactions occur when one assumes a higher internal wage.

The consumption and production adjustments within the separable framework correspond to the direct components 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 case, the production and income effect induce either an increase of off-farm labor supply or a decrease in the demand for hired labor.²⁰

¹⁷ 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.

¹⁸ If the direct tax-induced (negative) production effects predominate 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.

¹⁹ As long as labor and commercial inputs are complements in production.

²⁰ If the inputs are substitutes in production, and the production effect predominates, then the opposite adjustments hold.

Land tax

A land tax causes via a reduced shadow wage an intensification of on-farm labor input. Consequently, a higher output supply will be realized. Obviously, when labor markets are imperfectly competitive, a land tax leads to production adjustments. The consumption adjustments are affected in a similar way to those of an input tax. 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. That is, a decreasing demand for all goods. As expected, the taxation of land causes either an increase in off-farm employment or a decreasing demand for hired labor.

Value added tax

An increasing value-added tax implies a higher exogenous price only for purchased consumption 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 clearly determined.²¹

Assuming a higher (lower) internal wage, labor demand and, consequently, output supply will decrease (increase). In contrast to the production response, households' tax-induced consumption decisions are unclear. The higher price of market goods implicates via the direct component(s) a decreasing demand for market goods, but ambivalent adjustments regarding the consumption of self-produced goods and leisure. However, a higher (lower) endogenous valuation of leisure leads to an increasing (decreasing) 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, no tax-induced production adjustments result in applying the separable version, and consumption reactions coincide with the direct component of the non-separable framework. Similar to the non-separable version, labor market reactions are strictly speaking theoretically undeterminable²².

Some Interim Conclusions

Comparative static results suggest that when labor market imperfections occur most tax-induced allocation effects are theoretically unclear, mainly caused by counteracting shadow price components. This is especially true for all tax-induced labor market adjustments and for production responses of most tax policies. Only a wage tax and a land tax might clearly lead to an expansion of production, while the value-added tax would enforce a reduction. Also, tax-induced consumption effects are strictly speaking theoretically unclear, but in most cases an decreasing demand for consumption goods seems probable.

Furthermore, the analysis indicates that tax-induced farm household effects may differ between the separable and the non-separable model version. That is, labor market

²¹ As long as a value-added tax results in a higher demand for leisure, that is, substitutive 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.

²² 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 to the labor markets.

imperfections may have an impact on tax effects. In particular, production and consumption adjustments might differ for all agricultural taxes and the value-added tax, while an increasing income tax may imply different production, but similar consumption adjustments. However, the labor market adjustments of all taxes seem to fall in the same direction. In contrast, the wage tax probably induces similar production and consumption effects but different labor market adjustments within the two model versions.

Finally, basic results of optimal taxation and agricultural taxation literature have to be modified in part. In particular, since income and value-added taxes could imply production effects, they are no more necessarily superior to agricultural taxes in the sense of the optimal taxation theory²³. Analogously, since the presence of labor market imperfections implies that a land tax can lead to production adjustments and efficiency losses, it is no more clearly superior to market surplus or input taxes.

Empirical Specification

To clarify the direction and quantify the extent of the tax-induced farm household reactions, we estimate a full-specified non-separable farm household model. The data basis relies on a farm accounting survey undertaken in various regions in Mid-West Poland. Based on the estimated parameters we derive tax elasticities which capture the direction and extent of the tax-induced production, consumption and labor market reactions.

The farm household model is specified by following three modules. The production decisions are represented by a multi-output, multi-input profit function, from the translog form (e.g. Lau 1976, 1978). The translog profit function is flexible, but it is not global convex. Therefore, to protect the model against inconsistency we have to check convexity. The consumption decisions of the farm households are specified by an AIDS consumer demand system (Deaton and Muellbauer; Michalek and Keyzer). The AIDS is flexible, but not global concave. Therefore, we have to check concavity. Imperfectly competitive labor markets are represented by a convex cost function for hired labor and by a concave income function for off-farm family labor. Both functions are outlined as a Cobb Douglas.

The econometric estimation of the proposed model is carried out in three stages. In the first stage we estimate the cost function for hired labor ($g^*(X_l^h)$) and the off-farm income function ($f^*(X_l^s)$) as two unrelated log-linear regression equations:²⁴

$$(18) \quad \ln g_n^* = \ln \beta_h + \alpha_h \ln X_{ln}^h + v_n$$

$$(19) \quad \ln f_n^* = \ln \beta_s + \alpha_s \ln X_{ln}^s + \omega_n .$$

²³ One of the basic results of the optimal taxation literature is that, theoretically optimal taxation policies usually consist of a well-defined combination of consumption (value added) and income taxes, assuming those taxes imply no production effects. Diamond and Mirrless pointed out in their fundamental work, that production efficiency is desirable within an optimal taxation system, although a full Pareto optimum is not archived, since commodity taxes imply that marginal rate of substitution are not equal the marginal rate of transformation.

²⁴ To consider the possible occurrence of fixed transaction cost, we firstly estimate the cost function for hired labor ($g^*(X_l^h)$) and the off-farm income function ($f^*(X_l^s)$) as two nonlinear regression equations: (18*)

$g_n^* = \beta_h (X_{ln}^h)^{\alpha_h} + \kappa_h + v_n$ and (19*) $f_n^* = \beta_s (X_{ln}^s)^{\alpha_s} - \kappa_s + \omega_n$, where κ accounts for fixed costs of assessing labor markets. Since neither κ_h nor κ_s are statistically significant (i.e. no fix transaction costs occur), we prefer the more parsimonious linear specification of the labor markets.

Here n is the number of observation points and X_l^h and X_l^s indicate the farm-specific quantities of traded labor. β and α are the parameters to be estimated, and v and ω represent the random error terms, independently and identically distributed as $N(0, \sigma_v^2)$. Based on the estimated parameters, we can calculate the internal wage (P_l^*) for each individual farm household:

$$(20) \quad P_l^* = \begin{cases} \alpha_h \beta_h (X_l^h)^{\alpha_h - 1} & \text{if } X_l^s < X_l^h \\ \alpha_s \beta_s (X_l^s)^{\alpha_s - 1} & \text{if } X_l^s \geq X_l^h \end{cases}.$$

Since the parameters result from the estimation of two separate labor market functions, the shadow price might not be uniquely determined²⁵. Therefore, we derive the internal wage according to the household's position of net labor market accession. That is, if a household is a net off-farm labor supplier, the shadow wage is derived from $f^*(\cdot)$ (lower line), and if it is a net demander of hired labor we derive the internal wage from $g^*(\cdot)$ (upper line).

Considering the calculated endogenous wage rates, in the second stage we estimate the translog profit function ($\Pi(P^*(p^*), R)$) together with three of the profit share equations ($M_I = P_I^* X_I / \Pi; I = \{C, A, L\}$)²⁶ (Lau 1976, 1978):

$$(21) \quad \ln \Pi_n = \alpha_0 + \sum_{I \in PG} \alpha_I \ln P_{In}^* + \frac{1}{2} \sum_{I \in PG} \sum_{J \in PG} \beta_{IJ} \ln P_{In}^* \ln P_{Jn}^* + \frac{1}{2} \sum_{I \in PG} \sum_{k \in R} \delta_{Ik} \ln P_{In}^* \ln R_{kn} \\ + \sum_{k \in R} \phi_k \ln R_{kn} + \frac{1}{2} \sum_{k \in R} \sum_{s \in R} \gamma_{ks} \ln R_{kn} \ln R_{sn} + \xi_{\Pi n}$$

$$(22) \quad M_{In} = \alpha_I + \sum_{J \in PG} \beta_{IJ} \ln P_{Jn}^* + \sum_{k \in R} \delta_{Ik} \ln R_{kn} + \xi_{In}.$$

Here, P^* is the vector of the producer price indexes ($P_{I,J}^*$) and $X_{I,J}$; $I, J = \{C, A, V, L\} \in PG$ denotes the aggregated net outputs and net inputs. $R_{k,s}$ indicates the quasi fixed factors land (G) and capital (K), and α , β , δ , ϕ , γ are the parameters to be estimated.

In the last stage we estimate the household's consumption decisions via an AIDS consumer demand system consisting of three commodity groups: purchased commodities (C_M), self-produced consumption goods (C_A), and leisure (C_L). The following specification is used (Deaton and Muellbauer):

$$(23) \quad W_{In} = \alpha_I + \sum_{J \in CG} \beta_{IJ} \ln P_{Jn}^* + \gamma_I \ln \frac{Y_n}{\wp_n} + \omega_{In}$$

$$(24) \quad \ln \wp_n = \alpha_0 + \sum_{I \in CG} \alpha_I \ln P_{In}^* + \frac{1}{2} \sum_{I \in CG} \sum_{J \in CG} \beta_{IJ} \ln P_{In}^* \ln P_{Jn}^*.$$

Here, $W_I = P_I^* C_I / Y$; $I = \{M, L\}$ are the budget shares, where Y indicates the expenditures. $\wp(P^*(p^*))$ is the translog consumer price index, and P^* indicates the vector of the consumer price indexes ($P_{I,J}^*$) of the aggregates commodity groups (C_I ; $I = \{M, A, L\} \in CG$) and α , β , γ

²⁵ The separate estimation of f^* and g^* neglects the fact, that in equilibrium marginal cost of hired on-farm labor has to be equal to marginal off-farm income. Thus, we partly find different internal wage rates, when derived from the two functions.

²⁶ Because of the adding up conditions only three or the four share equations has to be estimated.

are the parameter to be estimated²⁷. Note that in particular to promote concavity of the estimated expenditure function, we establish exogenous commitments for leisure. Therefore, the (estimated) demand system, strictly speaking, corresponds to a (two-stage) LES-AIDS (Michalek and Keyzer)²⁸.

Data Description

Data used for the estimations are based on an accounting survey of a four year-panel (1991-1994) of agricultural households in several regions around Poznan (Mid-West Poland). The data was collected and published by the Institute for Agriculture and Food Industries (IERiGZ) in Warsaw. Initially, the data consists of an unbalanced panel of about 650 farms over the observation period. For this study, a balanced panel of 76 farms per annum is selected, i.e. we considered only those farms that were in the sample each year.

On the production side, pure market goods (X_C) consists of cereals, sugar beets, rape, and potatoes, while milk, beef, pork, poultry, and eggs were considered as home-consumed production goods (X_A). Commercial inputs (X_V) comprises fertilizer and chemicals, and labor (X_L) includes both family hand hired labor. Land (G) is considered as a quasi-fixed factor²⁹.

On the consumption side, C_M includes all purchased consumption goods, in particular nonfood including housing³⁰. C_A corresponds conceptually with the self-produced livestock products (X_A). The amount of leisure (C_L) is determined by calculating the yearly time (T_L) of households (household members older than 15 years \times 24 hours \times 365 days) minus on-farm (X_L^f) and off-farm (X_L^s) family labor.

Finally, we derived the transfers (E) by subtracting the total monetary income from the monetary consumption, $E = \sum_{I \in CG \setminus C_L} P_I^* C_I - \sum_{I \in PG \setminus X_L} P_I^* X_I - g^* + f^* - P_W^* X_W$, where $P_W^* X_W$ indicates the rental value of the residential building(s). Since the data set consists of detailed accounts for every farm and for every year, including disaggregated values and quantities, we can calculate individual price indexes. Appendix table A1, gives an overview of main sample characteristics.

²⁷ The simultaneous estimation of the translog total price index together with the demand system, which share the same set of coefficients, usually results in estimation problems (Michalek and Keyzer). In order to avoid these problems, as well as to avoid difficulties of approximating the translog price index by, say, a stone index (Deaton and Muellbauer 1980), we chose an iterative estimation procedure proposed by Michalek and Keyzer (p. 145).

²⁸ However, since our data base is limited regarding the consumption side in our model (see section ‘Data Description’) such that no commodity group consists of more than one element, there is no ‘true’ LES. Still one commitment can be estimated or exogenously determined. As noted, we establish exogenous commitments for leisure, that is we chose 70% as committed. Then the values of the committed expenditures are subtracted from the total consumer expenditures (Y). Then the uncommitted expenditures (Y^{uc}) are allocated among the upper level, which consists of three commodity groups: purchased commodities (C_M), self-produced consumption goods (C_A), and leisure (C_L), and estimated within the AIDS.

²⁹ Since capital was not significant, only land was considered in the final estimation.

³⁰ Since almost all farmers are owners of their residential buildings, we use calculated rental values as a measure of expenditures for housing. To identify the unbiased preferences, it is necessary to consider the expenditures for housing.

Empirical Results

Before beginning to present and interpret the main results, namely the tax elasticities, we use Appendix Table A2 to A4 to give an overview of the estimated parameters, the goodness of fit, and the theoretical consistency of the estimated model.

Parameter estimates, goodness of fit, and consistency

We found all parameters at the first stage ((18) and (19)) and third stage ((23) and (24)), except the parameter γ_{LL} in the budget share equation W_L , are significant at the 95% level. The equation system at the second stage ((21) and (22)) was first estimated with the complete set of parameters. Since several parameters were insignificant, we reduced the model via t-statistics to the following parameterization: α_i , β_{IJ} , δ_{IG} , and α_0 , where α_i and β_{IJ} are the price parameters, δ_{IG} is the price-land parameter and α_0 is the constant. At this point, most of the parameters became significant.

When evaluating the goodness of fit of the estimated farm household approach, that is, the eight estimated equations (two equations at the first stage, four at the second stage and two at the third stage) by the determination coefficients (R^2) of every single equation, we found R^2 to be between 0.21 and 0.95. While the ‘fit’ appears to be satisfactory for the labor market equations at the first stage with a R^2 of 0.69 and 0.95, and the budget share equations at the third stage given R^2 ranging from 0.79 to 0.83, the calculated determination coefficients of the profit share equations are relatively low (0.21, 0.38 and 0.59). The fact that the considered exogenous variables explain only 21% to 59% of the variance of the observed profit shares partly results from additionally parameter restrictions. This was done to retain convexity (see below). However, compared to other estimations of a flexible profit function the fit of the profit function is with an R^2 of 0.89 relatively high.³¹

Theoretically consistent estimations require, that the regularly conditions (adding-up, symmetry, homogeneity, monotony, and convexity and concavity, respectively) have to be fulfilled. The adding-up, the symmetry, and the homogeneity condition are enforced by parameter restrictions, but we have to check monotony as well as convexity and concavity. Monotony of the profit and expenditure function can be easily checked via the signs of the estimated profit and budget share, respectively³². We found that the monotony conditions are fulfilled (in all cases).

Finally, we check convexity and concavity via the semi-definiteness of the Hessian’s of the profit and expenditure function, respectively. The expenditure function is at almost all data points concave (except in six cases). In contrast, convexity of the profit function could only be insured in average over the whole observation period, by setting several parameters ($\beta_{CC}=0.5$, $\beta_{CA}=-1.2$, $\beta_{CL}=0.28$ and $\beta_{LL}=0.65$). Although taking the heterogeneous data base into account and considering the fact that insuring global convexity is always a problem when estimating flexible profit functions (e.g. Higgins 1986), we still have to admit that these

³¹ Since the equations at second and the third stage are estimated by SUR regression systems, and all three estimation stages are linked over the internal wage (P_L^*), the significance and the interpretation of the R^2 calculated separately for a single equation is limited. As Bewley pointed out, ‘...it is not particularly useful to calculate an R^2 for each equation if a system of equations has been derived from a single objective function, in some sense, all equations either fit together or the whole model is rejected’. Therefore, calculated R^2 have to be considered as indicators rather than as a test of the goodness of fit of the whole model.

³² If the expenditure and the profit shares have the “right” signs, that is, positive signs for the budget (W_I) and output shares ($M_I; I=\{C,A\}$), and negative signs for the input shares ($M_J; J=\{V,L\}$), then monotony of the expenditure and the profit function holds.

additional parameter restrictions partly reduce the evidence of the empirical results. Nevertheless, since the empirical analysis mainly aims at the identification of the direction and extent of the tax-induced farm household effects derived from the theoretical framework, we do prefer a theoretically consistent (but additionally restricted) over an less restricted (but inconsistent) estimation of the farm household behavior.

Tax elasticities

Tax elasticities presented here reflect the relative change of the respective economic variables with respect to the change of the analyzed tax parameters. In order to separate the impact of labor market imperfections, we derive tax elasticities assuming non-separability as well as separability. We compute the tax elasticities as a function of the relevant price and income elasticities, which are based on the underlying estimated parameters and calculated using the sample mean values of the relevant variables for 1994.

The tax elasticities correspond to the differentials in the comparative static analysis.³³ Analogous to equation (12), tax elasticities within the non-separable framework compound a direct component and indirect component:

$$(25) \quad \frac{\partial \ln Z}{\partial \ln \tau_j} = \frac{\partial \ln Z}{\partial \ln \tau_j} \Big|_{P_L^* = \text{const.}} + \frac{\partial \ln Z}{\partial \ln P_L^*} \frac{\partial \ln P_L^*}{\partial \ln \tau_j}.$$

Here $Z = (C_I, X_I, X_L^s, X_L^h)$ indicates the consumption and production goods, as well as supplied off-farm and hired on-farm labor, and $\tau_j; j = y, w, ms, v, r, vat$ are the tax parameters under investigation.

The direct component (first term of the right-hand side of equation (25)) reflects the tax induced reactions, assuming a constant endogenous internal wage. It is always a function of the estimated price and income elasticities. The indirect component (second term of the right hand side of this equation) represents households adjustments of the change in the internal wage, which is caused by the same tax parameter. It is the product of the shadow price elasticity and the 'usual' supply or demand elasticities regarding the internal wage. Note that as showed in the theoretical analysis, the direct component does not always correspond to the tax elasticities of the corresponding separable model version.

Tables 1 gives an overview of the tax elasticities within the non-separable framework, and table 2 documents the corresponding shadow price elasticities. Although the elasticity of the internal wage with respect to the income tax (-1.011) is the highest of the designated tax policies, we find unexpected low allocation effects as a result of an increasing income tax (τ_y) within the non-separable version. Only the adjustment regarding the commercial consumption good is relative high (-1.093), while all other elasticities fall between 0.001 and 0.112 in absolute values. The very low tax-induced farm household adjustments can be explained by the counteracting impact of the respective direct income effects and the corresponding indirect shadow price components, which compensate each other in most cases. Because leisure and market commodities are net-substitutes, the direct and indirect components affect the demand of market goods in the same direction.

include table 1

include table 2

³³ For the interesting reader the detailed derivation of the tax elasticities is available from authors.

An increasing taxation of off-farm labor (τ_w) leads to an increasing subsistence character of the farm households. Labor market transaction will be reduced to a great extent, especially for hired labor (-7.125). Further, the consumption of self-produced food and leisure increase, while the demand for market commodities decrease. However, on the production side, we find a slight increase in the supply of cash crops and in the demand of purchased inputs. Note, that the exclusive taxation of off-farm labor corresponds to the tax policy that has existed in Poland's agricultural sector during the observation period (1991-1994).

The most important and relative homogenous allocation effects will be induced by a market surplus and an input tax (τ_{ms} and τ_v). We find the general reduction of production activities with elasticities ranging from -0.652 up to -1.358 , a sharp decreasing consumption of purchased commodities (-3.112 and -1.265), and moderate consumption reductions of self-produced food and leisure. Furthermore, farmers will hire less labor but sell more off-farm labor, particularly in the case of a market surplus tax.

In particular, because of the relatively low shadow price reactions (-0.350 and -0.019), the production decisions seem to be determined by the respective direct components. In addition, the very elastic adjustment of market goods caused by an increasing market surplus tax can be explained by an additional direct hicksian substitution effect. In contrast to the input tax, the market surplus tax induces a lower (decision) price for the self-produced good enforcing the household members to substitute market commodities by self-produced goods.

overall, the land tax (τ_r) elasticities are around zero, especially due to very low shares of land assets and the low adjustment of the internal wage. A value-added tax (τ_{vat}) leads via the indirect (shadow wage) component to a slight decrease in the supply and demand of production goods, and to a relatively high decrease of the household's non-food consumption (-1.467). However, the consumption of self-produced goods does increase. Since the value of self-produced food cannot be observed and taxed (see above) the hicksian cross price effect 'works' against the (tax-induced) negative income effect, and forces households to substitute market goods by self-produced consumption goods.

In the case of perfect competitive labor markets (table 3), the income tax (τ_y) induces (as expected) no production adjustments, but, in contrast to the non-separable version, induces sharp adjustments of the consumption pattern, with elasticities ranging from -4.119 to -0.376 . In particular, the consumption of market goods will be reduced to a great extent (-4.119). Also the off-farm labor supply increases to a greater extent as in the case of non-separability.

include table 3

The production adjustments of an increasing wage tax (τ_w) are very similar to the non-separable version, but we find very different consumption and off-farm labor responses. While in the case of separability, a wage tax leads to a lower demand of all commodities (including leisure) and an increasing supply of off-farm labor, the opposite reactions occur for the self-produced agricultural goods and leisure as well as for off-farm labor.

As in the non-separable model, most important allocation effects will be induced by the market surplus and input taxes (τ_{ms} and τ_v). We find the general reduction of production activities with elasticities ranging from -0.656 up to -1.481 , a sharp decreasing consumption of market commodities (-2.977 and -1.258), and moderate reductions of self-produced food and leisure. Farm household responses of land (τ_r) and value-added taxes (τ_{vat}) are very similar to the non-separable version. This seems to be mainly caused by the low shadow price elasticities.

To conclude, the designed tax instruments partly induce different allocation effects within both the non-separable and the separable model version. In both model versions, the production effects of the standard tax instruments (income, wage and value added taxes) are ignorable or non-existing, but their consumption and labor market effects are remarkable. In addition, regarding the income and wage tax, consumption and labor market adjustments do differ between the two model versions, not only in extent but also partly in direction. Regarding the agricultural taxes, we find considerable production, consumption and labor market responses to increasing market surplus and input taxes, but no adjustments to an increasing land tax. Furthermore, the adjustments are very similar, in direction and extent, for the non-separable and separable model.

Considering these empirical results, we have to somewhat weaken our conclusions (see section ‘Some Interim Conclusions’) drawing from the theoretical analysis – at least in the Polish case. Since, the income, wage, and value-added taxes obviously imply ignorable production effects when compared with both market surplus and input tax, they seem to be superior to these specific agricultural taxes from the efficiency point of view. Analogously, since a land tax does not induce production effects, even in the case of non-separability, it seems to be superior to market surplus and input taxes, respectively.

Concluding Remarks

This paper provides a comparative static analysis and econometric estimation of farm households’ production, consumption, and labor market decisions under alternative tax policies. A non-separable farm household model is constructed implying increasing per-unit costs of accessing labor markets and thus accounting for labor market constraints. 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 for some reason or other 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.

Theoretical results suggest that when labor market imperfections occur most tax-induced responses are ambivalent mainly due to counteracting shadow price effects. This is especially true for the labor market reactions and for the production responses to most tax tools under study, while a decreasing demand for consumption goods seems to be probable in most cases. Furthermore, tax-induced allocation effects 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. Thus, income and value-added taxes are no more necessarily superior to agricultural taxes in the sense of optimal taxation theory (Diamond and Mirrless). 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.

Econometric analysis using individual household data from Mid-West Poland (1991-1994) indicate remarkable allocation effects induced by market surplus and input taxes, which are very similar in both model versions. In contrast, production responses to standard and land taxes are negligible or non-existing in both imperfect and perfect labor markets. In addition, regarding the income and wage tax consumption and labor market adjustments differ between

the two model versions, not only in extent but also partly in direction. Since standard and land taxes imply remarkably lower production effects compared to market surplus and input taxes they seem to be superior, at least in the Polish case.

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Tables

Table 1: Tax elasticities – non-separable model version (1994)

Tax	Farm			Household			Labor markets			
	$\frac{\partial \ln X_c}{\partial \ln \tau_j}$	$\frac{\partial \ln X_a}{\partial \ln \tau_j}$	$\frac{\partial \ln X_l}{\partial \ln \tau_j}$	$\frac{\partial \ln X_v}{\partial \ln \tau_j}$	$\frac{\partial \ln C_m}{\partial \ln \tau_j}$	$\frac{\partial \ln C_a}{\partial \ln \tau_j}$	$\frac{\partial \ln C_l}{\partial \ln \tau_j}$	$\frac{\partial \ln X_l^h}{\partial \ln \tau_j}$	$\frac{\partial \ln X_l^s}{\partial \ln \tau_j}$	$\frac{\partial \ln X_l^f}{\partial \ln \tau_j}$
τ_y	0.001	0.002	0.001	0.004	-1.039	-0.006	-0.012	-0.112	0.032	0.006
τ_w	0.091	0.139	0.250	0.064	-0.330	0.160	0.029	-7.125	-0.821	0.387
τ_{ms}	-0.800	-0.783	-1.358	-0.973	-3.112	-0.148	-0.187	-3.505	1.001	-1.261
τ_v	-0.714	-0.652	-1.124	-0.914	-1.265	-0.508	-0.114	-0.194	0.055	-1.098
τ_r^*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
τ_{vat}	-0.002	-0.003	-0.005	-0.001	-1.467	0.785	0.015	0.150	-0.043	-0.008

Source: Own calculations. Tax elasticities are calculated using the sample mean values of the relevant variables for 1994. *Land tax elasticities are overall around zero.

Table 2: Shadow price elasticities – non-separable model version (1991 – 1994)

Tax	Elasticity	Year			
		1991	1992	1993	1994
τ_y	$\partial \ln P_l / \partial \ln \tau_y$	-1.004	-1.008	-1.010	-1.011
τ_w	$\partial \ln P_l / \partial \ln \tau_w$	-0.548	-0.502	-0.549	-0.712
τ_{ms}	$\partial \ln P_l / \partial \ln \tau_{ms}$	-0.309	-0.316	-0.325	-0.350
τ_v	$\partial \ln P_l / \partial \ln \tau_v$	-0.040	-0.037	-0.044	-0.019
τ_r^*	$\partial \ln P_l / \partial \ln \tau_r$	-0.028	-0.020	-0.018	-0.015
τ_{vat}	$\partial \ln P_l / \partial \ln \tau_{vat}$	0.009	0.011	0.011	0.015

Source: Own calculations. The elasticities are calculated using the sample mean values of the relevant variables for 1991 - 1994.

Table 4: Tax elasticities – separable model version (1994)

Tax	Farm			Household			Labor markets**
	$\frac{\partial \ln X_c}{\partial \ln \tau_j}$	$\frac{\partial \ln X_a}{\partial \ln \tau_j}$	$\frac{\partial \ln X_l}{\partial \ln \tau_j}$	$\frac{\partial \ln X_v}{\partial \ln \tau_j}$	$\frac{\partial \ln C_m}{\partial \ln \tau_j}$	$\frac{\partial \ln C_a}{\partial \ln \tau_j}$	$\frac{\partial \ln X_l^h}{\partial \ln \tau_j}$
τ_y	/	/	/	/	-4.119	-1.680	-0.376
τ_w	0.128	0.195	0.350	0.089	-1.247	-0.096	-0.031
τ_{ms}	-0.845	-0.852	-1.481	-1.005	-2.977	-0.237	-0.204
τ_v	-0.716	-0.656	-1.131	-0.916	-1.258	-0.513	-0.115
τ_r^*	/	/	/	/	0.000	0.000	0.000
τ_{vat}	/	/	/	/	-1.473	0.789	0.016

Source: Own calculations. Tax elasticities are calculated using the sample mean values of the relevant variables for 1994. *Land tax elasticities are overall around zero. ** In the separable version, we supposed that farm households are net supplier of off-farm labor.

Annex tables

Table A1: Characteristics of the sample

Variable	Unit	Mean	Minimum	Maximum	Standard-deviation
X_a	1000 PLZ	96879	10930	592051	92925
X_c	1000 PLZ	53958	3033	320958	61272
X_v	1000 PLZ	65878	6088	366916	64138
X_l^h	man-hour	133	0	782	165
X_l^s	man-hour	612	0	2816	665
X_l^f	man-hour	3237	1228	6267	1361
C_a	1000 PLZ	17567	6288	44825	8218
C_m	1000 PLZ	36958	8583	111115	21314
C_L	hour	2544	1538	3942	605
$Land (R_G)$	hectare	9.9	1.2	44.0	8.3
$Capital (R_K)$	1000 PLZ	329090	21590	2727076	393807

Source: Own calculations based on IERiGZ (1995). PLZ= Zloty.

Table A2: Parameter estimates and determination coefficients - labor market functions (first stage)

labor market functions	Parameter (t-Value)		determination coefficient
	α_i	β_i	R^2
$g(X_i^h)$	1.1	2479.1 (66,31)	0,69
$f(X_i^s)$	0.5	349409.67 (106,4)	0.95

Source: Own calculations.

Table A3 : Parameter estimates and determination coefficients - profit function and profit share equations (second stage)

Profit function		Parameter (t-Value)			determination coefficient
Π	α_0	ϕ_k	γ_{ks}		R^2
	7.277 (2.91)				0.89
R_G		1	0	0	
R_K		0	0	0	

Profit share equations		Parameter (t-Value)					determination coefficient	
	α_I	δ_{Ik}			β_{IJ}	R^2		
M_C	1.5158 (2.69)	0.1463 (0.924)	0	0.5	-1.2	0.28	0.42	0.21
M_A	2.7243 (2.43)	-0.5272 (-3.12)	0	-1.2	-0.3974 (-0.728)	0.5179 (1.92)	1.0796 (1.45)	0.38
M_L	-0.3661 (-0.523)	0.4538 (5.41)	0			0.65	-1.4479	0.59
M_V		-0.0729					-0.0517	

Source: Own calculations.

Table A4: Parameter estimates and determination coefficients - budget share equations (third stage)

budget share equations		Parameter (t-Value)			determination coefficient	
	α_I	β_I	γ_{IJ}		R^2	
W_M	-1.906 (-7.04)	0.26997 (12.37)	-0.28405 (-7.45)		0.79	
W_A	1.15235	-0.037704	1.40E-01	6.96E-03		
W_L	1.7537 (7.60)	-0.232269 (-11.63)	1.44E-01	-0.1473 (-11.04)	3.62E-03 (0.125)	0.83

Source: Own calculations.