PRODUCT TAX MODELLING –

USING THE DYNAMIC INTERINDUSTRY MODEL INFORGE

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The impact and hence the appropriateness of discretionary fiscal policy on business cycles has been subject for theoretical and empirical dispute not only since reason times.

(Bode et al 2009: 1; author's translation)

While a consensus view has emerged as regards the empirical effects of monetary policy shocks, the empirical literature has struggled so far to provide robust stylized facts on the effects of fiscal policy shocks.

(Caldara & Kamps 2008: 6)

1 INTRODUCTION

As the introductory quotes show, the analysis of fiscal policy and its impact on business cycles and economic growth is neither theoretically nor empirically exhausted. For many years, empirical research in economics concentrated foremost on the effectiveness of monetary policy and less on fiscal policy. One reason might be that a wide consensus on the transmission of monetary shocks on the economy exists, whereas the transmission mechanism of fiscal policy shocks is still strongly debated among different economic schools. But developments like the Balance Budget Amendment in the USA, the debt brake amendment to Germany's constitution, the Stability and Growth Pact of European Currency Union or the world economic crisis in 2009 has shifted fiscal policy and its potential to initiate changes in economic activity in focus. The German Council of Economic Experts has observed (Bode et al. 2009: 2) that in Germany the application of simulation models to measure exogenous fiscal policy shocks does not have a long tradition. Only recently, work is intensifying and a growing number of publications on this subject can be found. With respect to tax systems, the need for sophisticated simulation models is currently increasing in Germany: for instance, in 2009, the government has announced in its coalition agreement to initiate a commission whose task is to investigate a system change in value-added taxation (Coalition Agreement 2009: 14).

Simulation models that can be applied for empirical analysis of fiscal policies mainly concentrates on vector autoregressive regression (VAR-)models followed by the application of computable general equilibrium models (CGE). To a smaller scale, micro simulation models (MSM) are also used. In this paper an empirical modelling approach is introduced which belongs in the same familiy of simulation models as CGE but with slightly different specifications. The macro-econometric model INFORGE is applied to analyze discretionary fiscal policy shock in Germany. The proceeding analysis concentrates on the modelling of product taxes which are a major contributor to state income and hence are an important tool for conducting fiscal policy.

Three objectives are pursued in this paper:

(i) The specifications of the macro-econometric model INFORGE are introduced.

(ii) The implementation of taxes on products in the modelling framework of INFORGE is described. This includes the identification of the location of product taxes as well as the setting of the database and the computing of regression equations for product taxes which are further differentiated into value-added taxes, import taxes and other product taxes such as excise duties. The different tax types are considered in the choice of regression approach.

(iii) An application of the new modelling approach for product taxes.

2 Fiscal Policy in Theory and in Empirical Research

2.1 Discretionary Fiscal Policy in Theory

The different views on the effects of discretionary fiscal policy on the economy can be traced back to different theoretical schools. Keynesian, neo-classical and new neo-classical synthesis theories are three important mainstreams in economics. In Table 1 an overview of the basic theoretical assumptions as well as the different transmission channels of fiscal policy stimulus are given.

Important for the investigation of the effects of fiscal policy analysis on the economy are the role of expectations and the degree of price flexibility. The assumption concerning expectations is important for triggering down the behaviour of private consumers to fiscal policy shocks. Rational expectations which are prominent in neo-classical and new neo-classical economic schools can be traced back to Muth (1961) and Lucas (1972). They argue that economic actors use their information efficiently and no systematic errors occur while they build their expectations (Dornbusch & Fischer 1987: 616). This idea has strong implication on the effectiveness of policy decisions. In case of a positive fiscal stimulus, households are capable in anticipating future tax increases and offer more labour in order to compensate expected income losses. In turn that means that private consumption is depressed because of higher private savings or the **negative wealth effect**. (Burnside et al 2002, Linnemann & Schabert 2000) Thus, positive fiscal shocks can only have positive effects on aggregate demand when fiscal policy is non-announced. In contrast, in a Keynesian world economic agents are not obliged to rational expectations, which allow positive aggregate demand effects.

Price rigidity is a special feature in Keynesian theory and an important assumption for understanding fiscal policy transmission. Fiscally induced increases in aggregate demand lead to higher production and labour demand. Because of sticky prices, real income increases which leads to an upswing in private consumption as well. When prices are fully flexible and markets are always cleared, this **demand-side effect** is not realized. Real income is unchanged and therewith private consumption. In this way of thought, the negative wealth effect and accordingly the **Ricardian equivalence proposition** dominates (Burnside et al 2002, Linnemann & Schabert 2000).

The synthesis of both economic streams combines features of both schools. Rational expectations coexist with sticky prices which also allow due to market insufficiency demand driven product and labour demand increase. (Linnemann 2003, Goodfriend & King 1997) The synthesis concentrates in the temporal allocation of supply-side and demand-side effects. In the short run, the demand-side effect dominates leading to changes in private consumption via real income changes. In the long run, economic agents are aware of the intertemporal budget constraints of the state which activates the wealth effect.

Table 1: Effects of fiscal policy in different theoretical schools

	Keynes	Neo-classic	New neo-classic
Basic assumptions			
Expectations	Irrational	Rational	Rational
Prices	Sticky	Flexible	Flexible
Recaridan equivalence	Non	Perfect	Intermediate
Fiscal policy shocks			
Effects	Demand effect	Wealth effect	Wealth effect + demand effect
Driven by	Demand-side	Supply-side	Supply-side in the long run demand-side in the short run
Fiscal multiplier	+	- when anticipated + when unanticipated	+ in short - in long
	Always positive, but in case of crowding-out smaller	Only positive when unanticipated	Positive when demand-side effect exceeds wealth effect

Source: Hemming et al 2002, Roos 2007, Linnemann & Schabert 2000, Linnemann 2003

All three theories assign fiscal policy the potential to affect the economy positively in case of a positive fiscal shock. In case of neo-classical and new neo-classical theory, the impulse of fiscal policy shocks depends on time and on non-announcement. Private consumption as important contributor to size and sign of the fiscal multiplier are affected differently depending on the transmission mechanism.

2.2 DISCRETIONARY FISCAL POLICY IN EMPIRICAL RESEARCH

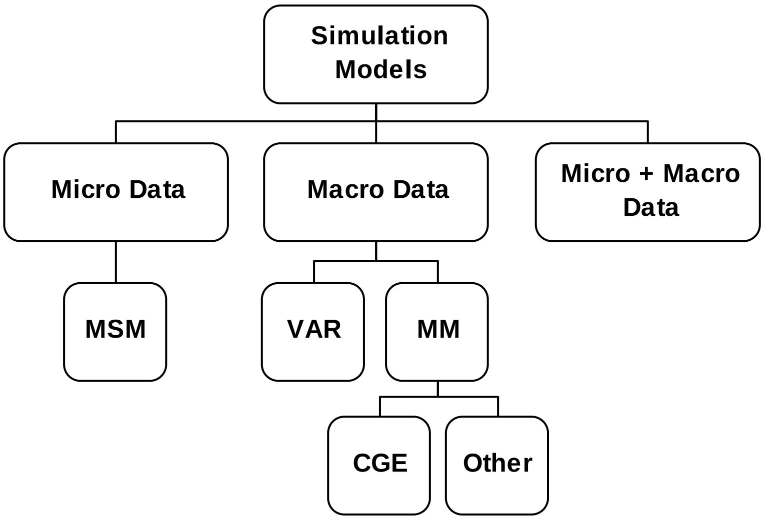
The discussion in the previous section shows that economic theory does not give a clear indication for the effectiveness of discretionary fiscal policy. Empirical research can help to understand the impact of discretionary fiscal policy on the economy, although the outcome heavily depends on the specification of the used model. Sign and size of fiscal multipliers therefore depend on their theoretical foundation as shown in section 2.1. However, for some issues to explore the sign and size of the fiscal multiplier is difficult to frame a-priori. In section 5, a simulation on restructuring of the German VAT-system is calculated in which it remains theoretically unclear whether the fiscal policy impulse is positive or negative. The application of simulation models can help to evaluate the effects of fiscal policy measures before they are implemented. Hence, simulations are some sort of “economic experiment” (Peichl 2005: 5) that help to generate “the response of a system to particular changes in exogenous conditions or to particular changes in the structure of the system itself” (Schmalensee 1970: 10).

Figure 1 offers a broad classification of different simulation models applicable to fiscal policy analyses. The main distinguishing feature is the usage of different types of datasets. Micro-simulation models (MSM) use micro data such as panel data or scientific use files.[1] Simulation models that use macro data (eg systems of national accounts) can be further classified according to their modelling approach. Macroeconomic models (MM)

[1] For a detailed introduction to micro-simulation models and their different configuration refer to eg Peichl (2005) or Bach (2005).

are models for total analyses and mostly complex with regard to data setting and structure. Recent advancements in simulation models combine micro and macro data.[1]

Figure 1: Classification of simulation models



Source: based on Peichl 2005; own composition

Micro-simulation models (MSM) are usually applied for simulating socio-economic, institutional or judicial effects of eg tax reforms. Hence, redistributional effects on a disaggregated level can be generated (Peichl 2005). Generally, MSM follow a partial analytical approach which lacks linkages to overall production and rebound effects on the economy.

Most of the empirical studies using macro data apply vector autoregressive simulation (VAR-) models (Perotti 2002, Plötscher et al 2004, Bode et al 2009, Baum & Koester 2011). These models are characterized by simultaneous analysis of relationships between two or more variables. According to Sims (1980), VAR-models have the advantage of being “unrestricted” (Sims 1980: 15) which means that they are free of assumptions, “apriori knowledge” or theoretical backup. They are mostly smaller and less structured than macro-econometric models (Roos 2007).

Other empirical studies apply macro-econometric simulation models (MM) for the analysis of fiscal policies. Macro-econometric models can evaluate the effects of fiscal policy shocks on business cycles and economic development. But due to their high level of aggregation, they normally lack detailed information on socio-economic or system factors (e.g. the detailed configuration of a tax system). In general MM-models are estimated “using complex and sophisticated econometric methods” (Wilson et al. 2007: 11). In majority, macroeconomic simulation models concentrate on the application of computable general equilibrium models (CGE) (Linnemann 2003, Stähler & Thomas 2011). These macroeconomic models focus on the calculation of simultaneous equilibrium solutions given exogenous pre-adjustments: “parameters are imposed rather than

[1] For a more information on micro-macro-simulation models refer to eg Peichl (2005) or Davies (2009).

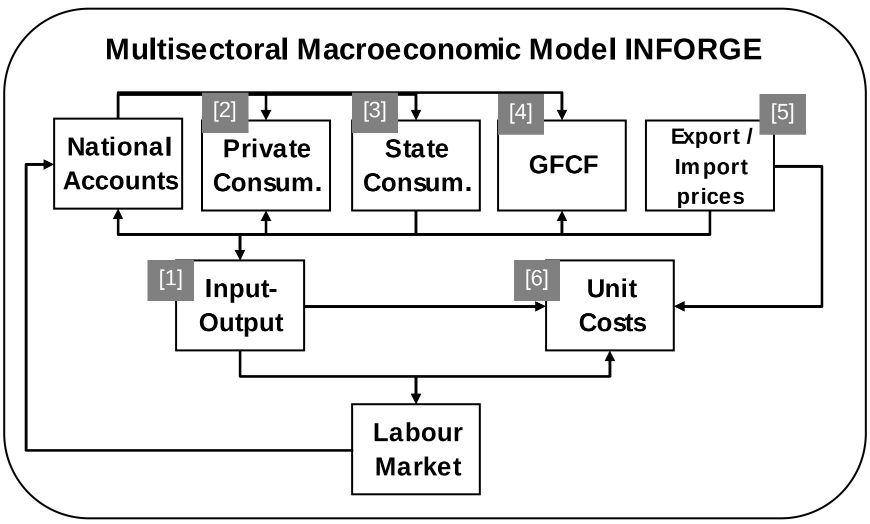
estimated"(Wilson et al. 2007: 11) (Almon 1991, West 1995). In most cases they follow neo-classical traditions. The basic dataset of CGE models are input-output-tables and national accounts (Dixon 2006).

In summary, empirical work on fiscal policy analysis covers a wide range of simulation models. The choice of models depends on the research question in focus. For total analyses which allow drawing conclusion on business cycles, economic growth and employment macroeconometric simulation models are preferable. CGE-models have become the standard tool in this category of modelling.

3 THE SPECIFICATION OF THE MODELLING FRAMEWORK

In this paper a macro-econometric simulation model for analysing fiscal policy shocks has been chosen. INFORGE (INterindustry FORecasting GErmany) has been developed by the Institute for Economic Structures Research (GWS) and is a multisectoral macroeconomic forecasting and simulation model for Germany. It belongs to the INFORUM modelling family (Almon 1991) with their two main features: bottom-up and total integration. It uses regression analysis to describe economic behaviour of different economic agents. Interindustry relations are explicitly used and change over time. Accounting consistency is assured at all time; on the production side as well as on the demand side. The bottom-up approach is characterized by a deep disaggregation on the sectoral level, enabling a detailed modelling of industries and goods. The integrated structure of the model allows a complex and simultaneous solution due to the absolute accounting consistency. Input-output tables are fully implemented in the system of national accounts allowing linkages between interindustry interdependencies, distribution of income, redistribution effects of the state and spending of income on goods. Production is determined by demand via the Leontief-equation. All determinants of demand depend on relative prices which again are a function of firm's unit costs and import prices. (Ahlert et al 2009, Distelkamp et al 2003). In Figure 2 a graphical specification with the major driving forces of INFORGE is given

Figure 2: Graphical specification of INFORGE



INFORGE corresponds in many features to standard CGE models (Almon 1991). Similar to them, it solves simultaneously and is dynamic over time. The basic dataset (input-output-tables and national accounts) as well as the non-linear functions coincide. Differences to other CGE-like modelling approaches are situated in the theoretical foundation of the model. CGE-models concentrate on equilibrium positions (West 1995) and follow in most cases neo-classical traditions. The applied model in this paper borrows from the school of evolutionary economics (Nelson & Winter 1982) as features like technological change, imperfect competition and interdependencies, or partially sticky prices are standard characteristics. In INFORGE, parameters and their elasticity values are estimated econometrically with given time series for a large number of variables, whereas most CGE-models calibrate their parameters on a given benchmark or obtain elasticity values from literature (Peichl 2005).

Integral element of input-output-modelling is the determination of intermediate demand between industries. Input coefficients represent the relation of intermediate demand to total production. Technological change is identified by applying variable input coefficients. They are endogenously determined with relative prices and time trend. Using the Leontief-inverse $(I-A)^{-1}$ and by multiplying it with final demand (fd) gives gross production (y) by 59 industries. (A) is the input coefficient matrix for 59 catagories of goods and 59 industries. (I) is the identity matrix. In the following equations the notations are as follows: lower case letters are vectors, upper case letters are either times series or matrices. The dimension of vectors and matrices are indicated with subscripts. The subscript *t* indicates time dependency.

[1] $$y_t = (I - A_t)^{-1} \cdot fd_t$$

In many macroeconomic models, private consumption is based on the almost ideal demand system (AIDS) approach (eg Kratena & Wüger 2006), which allows the estimation of consumption structures according to utility maximization behaviour and consequently does build upon the assumption of a representative individual (Deaton & Muelbauer 1980). Different to this approach, INFORGE estimates consumption patterns by 41 purposes of use (c) as a function of real disposable income (Y/P) and relative prices (p/P). For some consumption purposes, trends (T) as proxy for long-term change in consumption behaviour or the number of private households (H) is used as explanatory variable.

[2] $$c_{l,t} = c_{i,t}\left(Y_t / P_t, p_{l,t} / P_t, T, H_t\right) \qquad l \in [1,...,41]$$

INFORGE differentiates between ten classification of the functions of governments for modelling state expenditures a final consumption. 90% of total expenditures are solely due to three government functions alone: (i) public administration, military and social security, (ii) education and (iii) health and social welfare. Driving forces for state consumption are disposable income of the government (YG), employment (E) as well as demographic change (B).

[3] $$g_{k,t} = g_{k,t}\left(YG_t, E_t, B_t\right) \qquad k \in [1,...,10]$$

Gross fixed capital formation is the result of separate modelling of production investment (including other investments in equipment) and building investment. Production investments (i) by 59 industries are determined by industrial production (y). In some industries time lags are explicitly considered.

[4] $$i_{i,t} = i_{i,t}\left(y_{i,t}, y_{i,t-1}\right) \qquad i \in [1,...,59]$$

In 2011, processes in the trade balance have contributed 0.8% to Germany's real GDP growth and is therefore a major factor for economic growth in Germany. The modelling approach follows a cascade system which we refer to as a Foreign Trade Cascade System (FTCS). It is a step-by-step process which derives German exports by goods and services from GDP-growth projections of 56 trading partners of Germany. Projections of the economic development in Germany's world trading partners are taken from the International Monetary Funds (2011), the European Commission (2011) and the International Energy Agency (2011). By using bilateral trade matrices from the OECD (2011), import shares are derived in total and by product groups giving total export demand for Germany. This information is used for estimating the development of foreign incoming orders for industries which again determine turnover (to) of industries. Finally, nominal exports are computed using the derived information on world trade development.

[5] $$x_{i,t} = x_{i,t}\left(to_{i,t}\right) \qquad i \in [1,...,59]$$

Basic prices (p) which are decisive for entrepreneurs are the result of unit costs (uc) and mark-up pricing. The extend to which mark-up pricing can be realized depend on the market form prevailing in specific industrial sectors. In industries with monopolistic structures, mark-up pricing is easier to realize than in competitive industrial structures. Price stickiness is obtained by estimating price elasticities lower than 1. Industries that are strong in exports also have to consider import prices (pim) as they are exposed to foreign competitors as well. Thus, the price setting behaviour of firms depends on two factors: (i) on the cost structure of a firm and (ii) on the price pressure caused by competing import goods. When the firm has decided on its sales prices, the demand side reacts accordingly which again affects production output (Meyer & Wolter 2007).

[6] $$p_{i,t} = p_{i,t}\left(uc_{i,t}, pim_{i,t}\right) \qquad i \in [1,...,59]$$

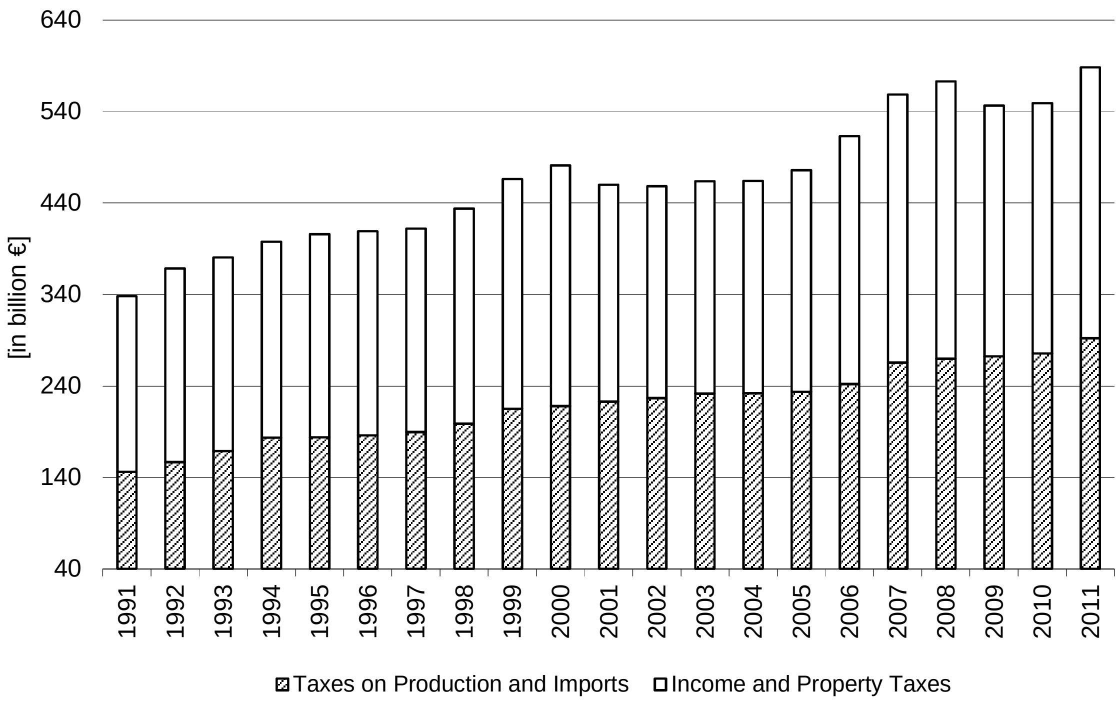
4 PRODUCT TAXES IN GERMANY

According to §3 I AO (German fiscal code – *Abgabenordnung*), a tax is defined (i) as a forced levy paid in monetary units, (ii) have no assignable return services, (iii) are levied by public authorities, (iv) are levied on the ground of law and (v) are not purpose-bound. Using the words of the Organisation of Economic Cooperation and Development – taxes are “compulsory, unrequited payments to general government” (OECD 2006 p 10). Taxes have to be distinguished from fees and contributions, whereby fees are individually and directly assignable to certain services, and contributions are hires for specific services that are not individually assignable, but for groups.

Taxes are levied in general for three major reasons: there is a fiscal purpose, a steering purpose and a redistribution purpose. The fiscal purpose secures the liquidity of the public household and constitutes the main income source of the public sector. The tax to total state income ratio fluctuates around 50%. In 2010, a ratio of 53% was recorded. Taxes are often perceived as a steering tool. Taxes aim at internalizing external effects that are assumed to have negative implications for the society or the environment and they are influencial on individual behaviour. Specific consumption taxes like tobacco tax, eco-tax, custom duties or mineral oil taxes are important examples. The steering function seems to collide with the fiscal purpose of taxes, because the more efficient the steering function works, the less tax revenues can be expected. But as Homburg (1997 p 6-7) observes, taxes with a steering purpose often veil mere fiscal interest to gain more revenues or to favour certain interest groups. Taxes also play an important role as a redistributional tool. In this function, taxes are used to flatten income and wealth differences among citizens. Important examples for this tax function are capital transfer taxes or asset taxes. The progressively designed income tax is a further example.

Tax revenue consists of production and import taxes on the one hand and taxes on compensation of employees and property on the other. Since beginning of this century, the revenues of two tax groups drift apart: the income from production and import taxes is becoming more important than income and property tax revenues (compare Figure 1). In 2011, indirect taxes on production and imports – which actually are taxes on consumption – contributed 50% to total tax income. The shift from labour and asset taxes was fostered in the early years of the new century, when income and property taxes were constantly reduced. Since 2000, indirect taxation of consumption increased in average by 2.7% pa, while income and property taxes increased by only 1.1% pa at the same time.

Figure 1: Tax revenues of direct and indirect taxation



Source: Federal Statistical Office (2012)

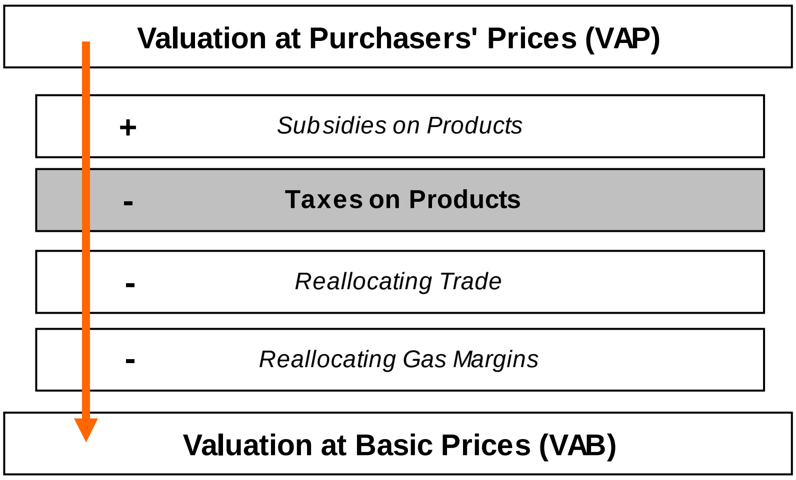
If production and import taxes are further divided, almost 94% (2011) of the revenues are composed of taxes on products. These in turn can be split into three major groups: value added taxes (VAT), taxes and duties on imports and other taxes on products such as excise duties. Value added tax revenue dominates with 68% total revenues of taxes on products. Other taxes on products have constantly dropped over time and currently determine 25% of total product tax revenues.

Those three tax types – VAT, import taxes and other taxes on products – can be categorized into general and specific consumption taxes. General consumption taxes are taxes levied on the turnover of all consumed products. In contrast, specific consumption taxes are taxes levied on the consumed quantity of a certain good or service. Whereas under general consumption taxes, all products underlie the same tax rate and the same tax base, the tax rate and tax base of specific consumption taxes vary according to the taxed object. Value added taxes are normally classified as a general consumption tax. Although VAT exemptions exist and in most countries a reduced tax rate persists, one can say that all products are levied with the same tax rate. The tax base is in all cases the turnover of the taxed product. In Germany, the current uniform VAT rate prevails at 19% and the reduced VAT rate at 7%. VAT exemptions prevail for example for housing, shipping or aviation. Excise duties or other specific consumption taxes belong to the specific consumption tax category. They are tax types which are constructed for a specific product or category of goods and are levied on the quantity consumed. Import taxes can be classified as either general or specific consumption taxes. Import taxes such as custom duties are specifically designed for a certain product. Their tax base can be either a quantity or turnover. The same holds for other import taxes such as specific excise duties on imported products. But also a value added tax or a general excise duty on imported products is collected. For the following discussion, import taxes are characterized as general consumption taxes.

4.1 Price Concepts and the Location of Taxes on Products

Within the national accounts two major price concepts are distinguished: valuation at basic prices (VAB) and valuation at purchasers' prices (VAP). While the valuation at basic prices is leading for production decision, the valuation at purchasers' prices determines the behaviour of consumers. The transition from valuation at purchasers' to basic prices considers subsidies, taxes on products and the reallocation of trade, gas and transport margins. Production is positively correlated to net final demand at basic prices, whereas demand for goods or other factors such as labour or capital reacts on purchasers' prices. The influence of taxes and subsidies on goods and services are eminent: they distort market prices and may lead to price-induced changes in consumption and/or production. The transition from total demand at purchasers' prices to total demand at basic prices is condensed in valuation matrices.

Figure 2: Valuation matrices: transition from VAP to VAB



Subsidies on products are added, taxes on products are deducted from total demand at purchasers’ prices. Additionally, trade margins have to be reallocated during the transition. The reallocation is needed, because the valuation at purchasers’ prices implies the allocation of trade margins to the product to which they pertain. A valuation at basic prices implicates that trade margins are recorded as services offered by the trade industry. Thus, during the transition from purchasers’ to basic prices trade margins are deductibles. As a consequence of the reallocation of trade, the sum over all categories of goods is per definition zero.

Each transition matrix has exactly the same configuration: for 59 categories of goods and services in the rows, the transition value for each component of final and intermediate demand is given. Each transition matrix for taxes on products (VATX, EXDX, IMPX) show the total of tax revenues for each component of total demand and for each category of goods and services.

Figure 3: Configuration of the valuation matrices of product taxes

		1 intermediate demand	2 private consumption	3 consumption of non-profit organization	4 state consumption	5 fixed capital formation	6 construction	7 changes in inventory	8 export	9 Σ(j=2,..,8): final demand	10 Σ(j=1,..,8): total demand
agriculture, hunting and related activities	1										
forestry, logging and related services	2										
..											
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..											
..											
..											
..											
other community, social and personal service activities	58										
services of private households	59										
Σ(i=1,..,59): total goods and services	60										

4.2 The Technical Implementation of Taxes on Products

4.2.1 Database Setting

Transition matrices for all variables of the transition process from valuation at purchasers' prices to valuation at basic prices are available from Distelkamp (2002). Thus, sectoral disaggregated information for subsidies on products, taxes on products as well as for the reallocation of trade, transport and gas margins were given for a time period from 1995 to 2004.

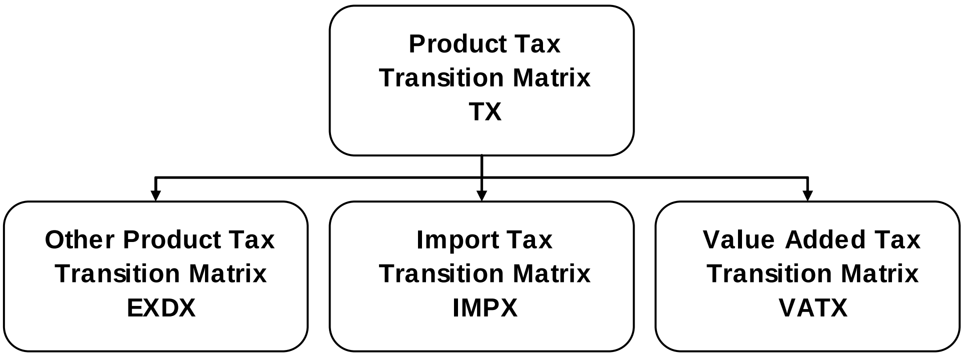
When the impact of specific product taxes or value added taxes on consumption has to be quantified, a separation of taxes on products becomes necessary. Accordingly, the transition matrix of taxes on products has to be further unbundled in its individual components: The aggregated transition matrix of product taxes (*TX*) has to be broken down in three specific product tax matrices:

(i) value added tax matrix (VATX),

(ii) import tax matrix (IMPX) and

(iii) other taxes on products matrix (EXDX).

Figure 4: Unbundling the Product Tax Transition Matrix (TX)



Other taxes on products subsume all other tax types that become payable as a result of further usage of taxable goods. Excise duties are one of the most important consumption taxes and are levied on the consumption of specific goods. The tax revenues are collected by the toll administration. The following goods are levied with an excise duty: crude oil & natural gas, beverages, tobacco, mineral oil commodities, electricity, insurance premiums and real estate services.[1] For each listed category of goods, information exists for tax rates (exds), tax base (exdb) and tax revenue (exdr). The tax matrix for excise duty revenues (EXDX) is conceived by multiplying the revenue of excise duties (exdr) with the given proportion of each component of total demand with total demand. Than the matrix EXDX is scaled on its basic value of the system of national accounts (SNA).

[7] $$EXDX_{i,j,t} = TX_{i,j,t} / \sum_{j=1}^{8} TX_{i,j,t} \cdot exdr_{p,t} \qquad i \in [1,...,59];\; j \in [1,...,8];\; p \in [1,...,24]$$

The calculation of import tax revenues for i categories of goods and j components of total demand is challenging as no insight is given about the volume of import tax revenues for each element of the import tax matrix. Therefore, an overall import tax quota ($IMPQ_t$) has been calculated, which shows the portion of import tax revenues ($IMPR_t$) on total revenues of taxes on products in Germany. Total revenues of product taxes are the sum of total value added tax revenue ($VATR_t$), total import tax revenue ($IMPR_t$) and total revenue of other taxes on products ($EXDR_t$). Over time, the import tax quota remains relatively stable, fluctuating around 7% of total product taxes. Assuming a constant import tax quota for all components of total demand and for all categories of goods, the import tax matrix IMPX can be received. Afterwards, the result is scaled on its basic value of the SNA.

[8] $$IMPX_{i,j,t} = \left(IMPR_t / \left(VATR_t + IMPR_t + EXDR_t\right)\right) \cdot TX_{i,j,t} \qquad i \in [1,...,59];\; j \in [1,...,8]$$

The value added tax matrix (VATX) is determined by definition. By deducting EXDX and IMPX from the historical given TX, the residual tax matrix shows the value added tax revenues for i categories of goods and j components of total demand.

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[1] The taxation of nuclear fuel was introduced in January 2011 but the present re-evaluation of the usage of nuclear energy is likely to lead to a quick end of this excise duty.

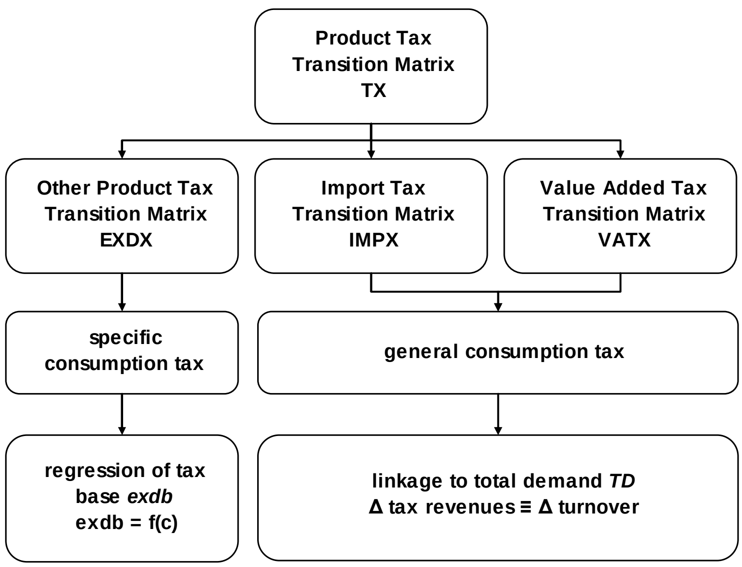
$$[9] \qquad VATX_{i,j,t} = TX_{i,j,t} - EXDX_{i,j,t} - IMPX_{i,j,t} \qquad i \in [1,...,59]; \; j \in [1,...,8]$$

4.2.2 Modelling Taxes on Products

The extrapolation of taxes on products underlies two different approaches depending on the tax type under review: specific or general consumption taxes. Specific consumption taxes such as excise duties depend on the consumed quantity of a certain product which forms the tax base. Each tax base is estimated individually. Tax revenues are received by multiplying the tax base with its tax rate. Tax rates are constant over time but subject to exogenous manipulation. In contrast, the tax revenues of general consumption taxes such as VAT, depend on the turnover of the consumed product. The leading indicator is the development of private consumption at purchasers' prices. Industries are mostly exempt from VAT but exceptions prevail which is why intermediate consumption has to be considered as well. The differences of these two approaches become evident, when the effects of price changes on tax revenues are highlighted. An increase in turnover leads automatically to an increase in general tax revenues, independent whether the increase in turnover was induced by a rise in quantity or an increase in prices. Differently to quantity based taxation, where price changes have no impact on tax revenues.[1]

According to the above outlined observation, other taxes on products such as excise duties, which are specific consumption taxes, are estimated by regression equations (see section 4.2.2.1). Value added taxes are general consumption taxes and are projected with the linkage approach (see section 4.2.2.2). Import taxes are also classified as general consumption taxes. Figure 3 summarizes the modelling approach for products on taxes in INFORGE.

Figure 3: Modelling taxes on products in INFORGE



[1] Under the condition, that price changes are not induced by an increase in tax rates.

4.2.2.1 Specific Consumption Taxes

The tax revenue is a product of tax rate and tax base. For specific consumption taxes, the tax base is generally expressed in physical terms such as kilograms or liters. The tax base is than multiplied with a certain tax rate which gives the monetary equivalent of the specific tax revenue. In INFORGE the dependent variable for specific consumption taxes is the physical tax base (exdb). The regressand is a positive function of consumption expenditures in purposes of use in constant prices (c).

[10] $$exdb_{p,t} = exdb_{p,t}\left(c_{l,t}\right) \qquad l \in [1,...,41];\; p \in [1,...,24]$$

Tax rates on excise duties remain constant as they are obliged to legislative decisions. In INFORGE they are exogenous variables which can be used for scenario analyses. By multiplying the dependent variable with its corresponding tax rate (exds) by each category of goods, the hypothetical tax revenue (exdr) for other taxes on products is received. The prefix *hypothetical* is used at this stage, because the predicted hypothetical tax revenue cannot fully correspond with the actual tax revenue. This is because diverging tax rates for different goods within the same category of products persist.[1] The projection of the matrix of other taxes on products is obtained by multiplying each element of the matrix of other product taxes of the previous year $\left(EXDX_{i,j,t-1}\right)$ with the growth rate of the hypothetical tax revenues $\left(exdr_{p,t} / exdr_{p,t-1}\right)$.

[11] $$EXDX_{i,j,t} = EXDX_{i,j,t-1} \cdot exdr_{p,t} / exdr_{p,t-1} \qquad p \in [1,...,24];\; i \in [1,...,59];\; j \in [1,...,8]$$

The introduced modelling approach for excise duties is limited to the assumption that the allocation of tax revenues to the components of total demand is assumed to be constant over time.

In the following two examples for the regression results of the excise duty tax base for for beer and tobacco are shown. Generally, an increase in real consumption expenditures raises the physical consumption of this product which leads to an increase in tax revenues which is why a positive correlation between tax base and consumption is presumed.

Excise duties on beer are levied on the sold quantity of malt beer and beer mixtures. Non-alcoholic beer is not object of taxation. The tax depends on original gravity of beer which is usually measured in degrees Plato. The regular tax rate is 9.44 Euro / hectolitre beer of 12 degree Plato. The number of observations for the consumed quantity of beer is given for a time period beginning in 1991 to 2010. Given the change in legislation in 1993, when beer taxation was harmonized in Europe, the regression starts in 1994. The number of observations (T) is hence limited to 17 points. The tax base of beer $\left(exdr_{beer}\right)$ is estimated with real consumption of private household of alcoholic beverages $\left(c_{alcohol}\right)$. Beer consumption in Germany declines constantly due to a behavioural change in alcohol consumption. A shift to the consumption of more popular drinks like cocktails, alcopop etc.

[1] For example the tax rate for cigarettes differs to the tax rate for tobacco shag; nonetheless, both are classified to the category <tobacco>.

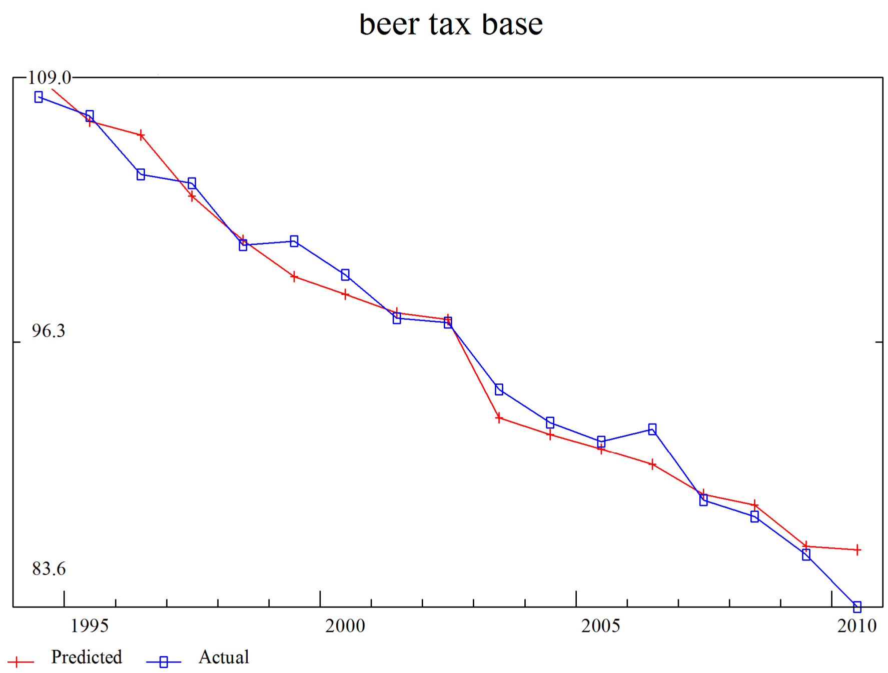
can be observed. Behavioural change is represented in the regression function with a time trend (TIME). The dummy variable $(D_{t=2003,FF})$ was set in 2003 when the regular tax rate for beer changed. The value of D remains 1 for the following periods which is indicated in the subscript FF. The regression function gives a degree of freedom (DF) of 14 periods. The Durbin Watson test (DW) indicates no autocorrelation. Real consumption expenditure of alcoholic beverages seems to explain the tax base rather well as the fit of regression measured by $\overline{R}^2$ is high. Additionally, the t-statistic (t-value) shows that real consumption expenditure is significant for the tax base of beer. Figure 5 displays the graphical course of the predicted and actual beer tax base.

Table 1: Regression results of the tax base BEER

$$exdb_{beer,t} = \beta_1 + \beta_2 \cdot c_{alcohol,t} / TIME_t + \beta_3 \cdot D_{t=2003,FF}$$

	T = 17	DF = 14	DW = 1.51	$\overline{R}^2$ = 0.9716
	β_1	β_2	β_3	
Reg-Coef	42.0	287.8	-3.4	
t-value	7.6	11.0	-3.2	

Figure 5: Graphical illustration of the predicted and actual beer tax base

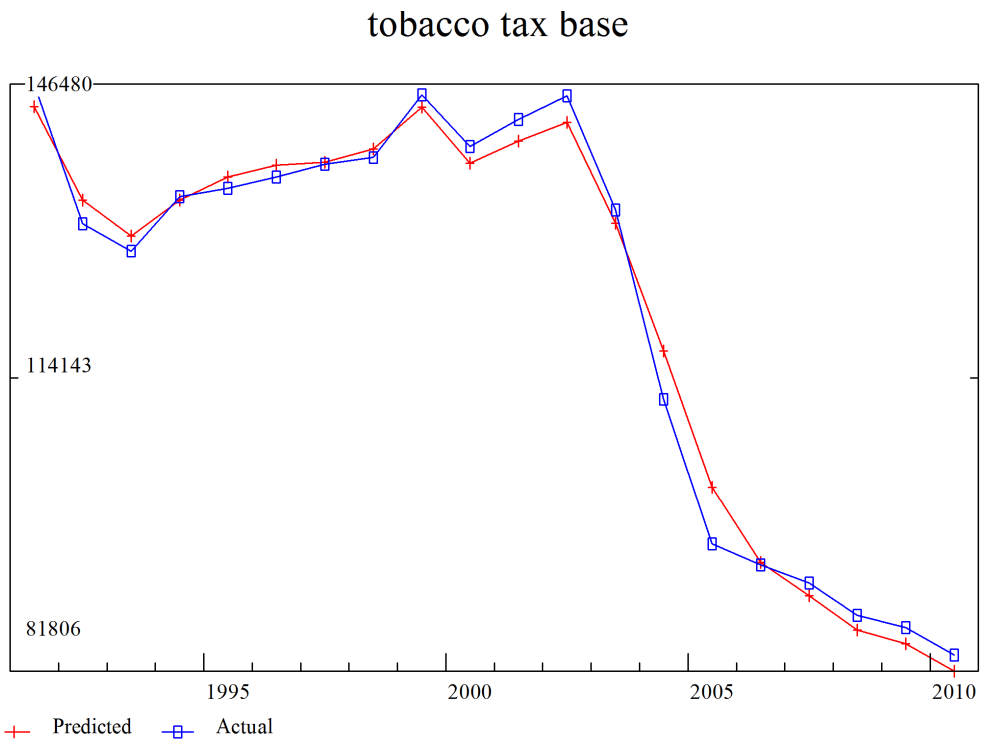


Excise duties on tobacco comprise cigarettes, small cigars, cigars and tobacco shag. The tax is levied on the consumed quantity of tobacco. Each type of tobacco is differently taxed. Cigarettes are currently levied with 0.08 Euro per cigarette; (small) cigars with 0.014 Euro per cigar; tobacco shag are levied with 48.49 Euro per kilo. Around 90% of tobacco tax revenues are yield by the consumption of cigarettes. This is why in INFORGE cigarette consumption $(c_{tobacco})$ is leading for estimating the tax base of tobacco $(exdb_{tobacco})$. The observation period (T) of the quantity of sold cigarettes comprises 20 periods. The number of degrees of freedom (DF) is reduced to 19. The test on autocorrelation (DW) is less robust with 0.65. But real consumption expenditure of tobacco seems to explain the tax base rather well as the fit of regression measured by $\overline{R}^2$ is high. Additionally, the t-statistic shows that real consumption expenditure for tobacco is significant for the tax base of tobacco. Figure 6 illustrates the predicted and actual course of the tax base of tobacco in Germany.

Table 2: Regression results of the tax base TOBACCO

$exdb_{tobacco,t} = \beta_2 \cdot c_{tobacco,t}$				
	T = 20	DF = 19	DW = 0.65	$\overline{R}^2$ = 0.9746
	β_2			
Reg-Coef	4438.7			
t-value	151.0			

Figure 6: Graphical illustration of the predicted and actual tobacco tax base



4.2.2.2 General Consumption Taxes

The linkage approach has been chosen for the prediction of import taxes and value added taxes. To forgo direct regression is the consequence of two assumptions:

(i) According to the design and intention of consumption taxes, a positive correlation between VAT or import taxes and consumption is assumed. An increase in consumption expenditures at purchasers' prices leads to a higher turnover of goods and services which automatically leads to an increase in VAT and import tax revenues.

(ii) Further, it is assumed that the allocation of tax revenues remains constant over time, category of good and component of total demand. This assumption corresponds to the one put forward in section 4.2.2.1.

The tax matrices for general consumption taxes (VATX and IMPX) are extrapolated with the projected consumption of total demand at purchasers' prices (TD). Equation [12] and [13] show the programming code. The two matrices VATQ and IMPQ give the ratio of tax revenue to total demand by i categories of goods and for each j component of total demand. They can be interpreted as the tax rates for value added taxes and import taxes. Nevertheless, those tax rates do not resemble the actual tax rates in the economy, because in some categories of goods products with differently assigned tax rates can be summarized. This is especially the case in the category of food and beverages, where normal and reduced VAT rates co-exist.

[12] $$VATX_{i,j,t} = \overline{VATQ}_{i,j,t} \cdot TD_{i,j,t} \qquad i \in [1,...,59];\ j \in [1,...,8]$$

[13] $$IMPX_{i,j,t} = \overline{IMPQ}_{i,j,t} \cdot TD_{i,j,t} \qquad i \in [1,...,59];\ j \in [1,...,8]$$

The new total tax transition matrix on taxes on products (*TX*) is determined by adding the three single tax matrices.

5 SIMULATION ON VALUE ADDED TAXES

This section shows an application of the modelling approach for product taxes but with special focus on value-added taxes. Three simulations on alternative value-added tax rate systems are computed in order to determine the tax rate level at which revenue-neutrality relative to the baseline scenario is guaranteed. Revenue-neutrality means, that no higher or lower level of tax revenue is perceived when the new tax system is introduced. This stipulates that economic growth remains unchanged relative to the baseline scenario.

The scenario has a specific German policy background. Currently, the co-existence of two different VAT-rates is under review. In its 2009 coalition agreement, the current government detected a need for action with respect to the reduced VAT-rate (Coalition agreement 2009: 14). The reasons, why certain goods and services are taxed by the reduced VAT-rates and others not are to be put to test. The review-process will be conducted by a commission which is still to be established.

At the meantime, other economic institutes and councils have worked on the future design of the VAT-system. Ismer et al. (2010) suggested stipulating a uniform tax rate of 19% on all goods and services other than food products – which hold the only legitimate justification for being taxed with the reduced tax rate. By applying a static scientific-use-file analysis, Ismer et al. (2010) estimate with moderate reallocation effects for low-income households and with an annual tax revenue effect of 9.3 billion Euros.

The German Council of Economic Experts has conducted a more sophisticated analysis on the same subject by applying a micro-simulation model updated to the sample survey of income and expenditures of 2008. They recommend a uniform VAT-rate of 16.5% for all goods and services – also for food products. At this tax rate, tax revenue remains unchanged compared to the baseline scenario and reallocation effects remain low.

A compilation of the simulation and results conducted by Ismer et al. (2010) and SVR (2010) are given in Table 3.

Table 3: Compilation of simulation and results

	Simulation	Results
Ismer et al. (2010)	19% uniform VAT-rate except for food products (7%)	Moderate reallocation effects for low-income households Additional tax revenue: 9.3 billion Euro p.a.
SVR (2010)	16.5% uniform VAT-rate	Revenue-neutrality Low reallocation effects
	19% uniform VAT-rate except tax exemptions	Additional tax revenue: 24.4 billion Euro p.a.
	19% uniform VAT-rate also for housing	Additional tax revenue: 41.2 billion Euro p.a.
	19% uniform VAT-rate except for food products (7%)	Additional tax revenue: 10.3 billion Euro p.a.

In the following, the results conducted with the macro-econometric model INFORGE are presented relative to the baseline scenario without VAT-rate changes. It is assumed that the tax reform is realized in 2013. The projection runs until 2016, in order to capture adjustment processes. Three scenarios are calculated. According to the simulation specification, the tax ratio matrix VATQ is manipulated:

(i) **Simulation 1:** A uniform VAT-rate of 14.0% on all goods and services is implemented. Tax exemptions remain.

(ii) **Simulation 2:** A uniform VAT-rate of 19.0% on all goods and services is implemented. Tax exemptions remain.

(iii) **Simulation 3:** A uniform VAT-rate of 16.0% on all goods and services is implemented. Tax exemptions remain.

In Figure 7, the simulation results of all three scenarios with respect to real GDP are given. The black line gives in all three diagrams the baseline scenario. The results show, that an almost revenue-neutral VAT-system can be obtained when a uniform VAT-rate of 16% on all goods and services are levied.

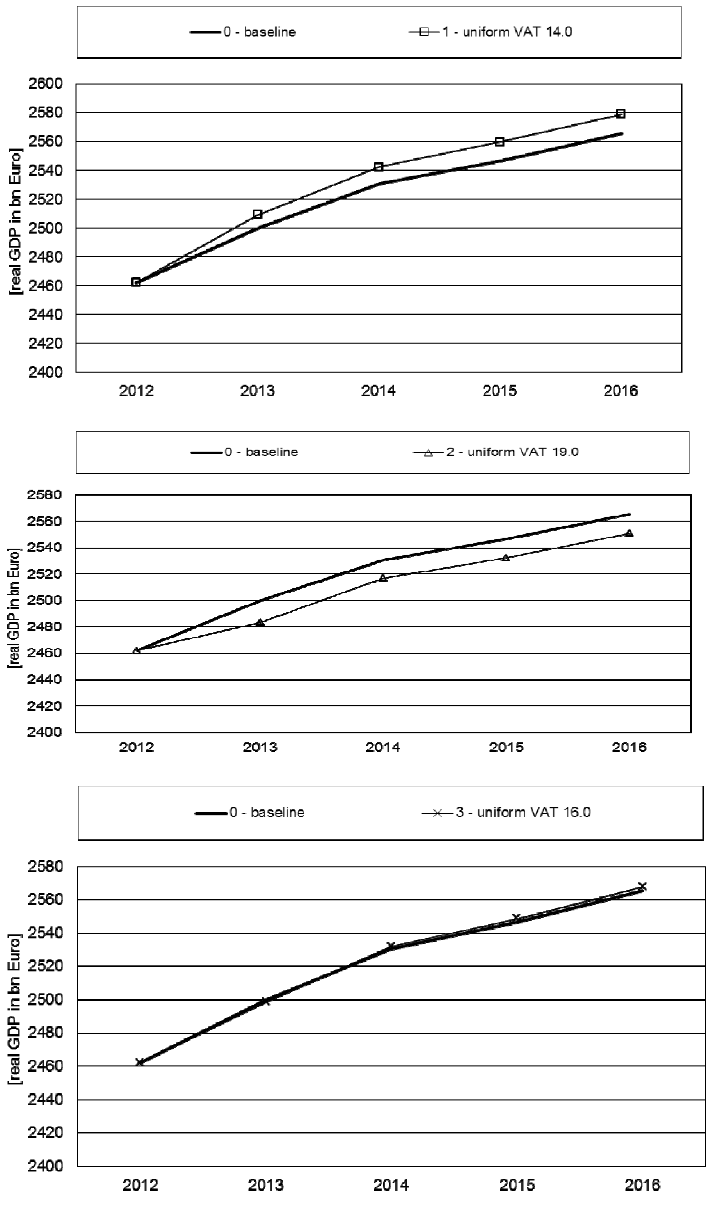
A uniform VAT-rate of 14.0% generates a higher real GPD growth relative to the baseline scenario of 0.5% or 13 billion Euros. This is due to a positive income effect especially for private households. Decreasing prices stimulate private consumption via a positive real income effect. Total private consumption increases by 0.9% in 2013 relative to the baseline scenario. On the other hand, product tax revenues are decreased. Approximately 9 billion Euros less product tax revenues are collected each year.

The results for simulation 2 indicate a negative effect on real GDP. The negative effect are higher than the positive effect in simulation 1 as price changes relative to the baseline scenario occur for all goods and services initially being taxed with the reduced tax rate – that also includes taxes on food products. Comparatively high price increases of about

2.0% relative to the baseline scenario lead to a decline in real private consumption expenditures of 1.6% or 22 billion Euros in 2013. Tax revenues are affected positively with an annual increase of 21 billion Euros. Additional state income is used for consolidation measures leading to an improvement in net borrowing.

Simulation 3 indicates no significant deflection from the baseline scenario. Small differences occur due to statistical effects: a uniform VAT-rate of 16% induces no price changes for goods and services relative to baseline. Positive price impulses given by the increase of the reduced tax rate to 16% are balanced by the negative impulses given by the decrease of the uniform VAT-rate of 19%. The balancing effect emerges due to the fact that more goods and services are levied with a normal VAT-rate of 19%. The small price changes on aggregate level have no impact on real private consumption and on real GDP. Product tax revenues remain unchanged as well.

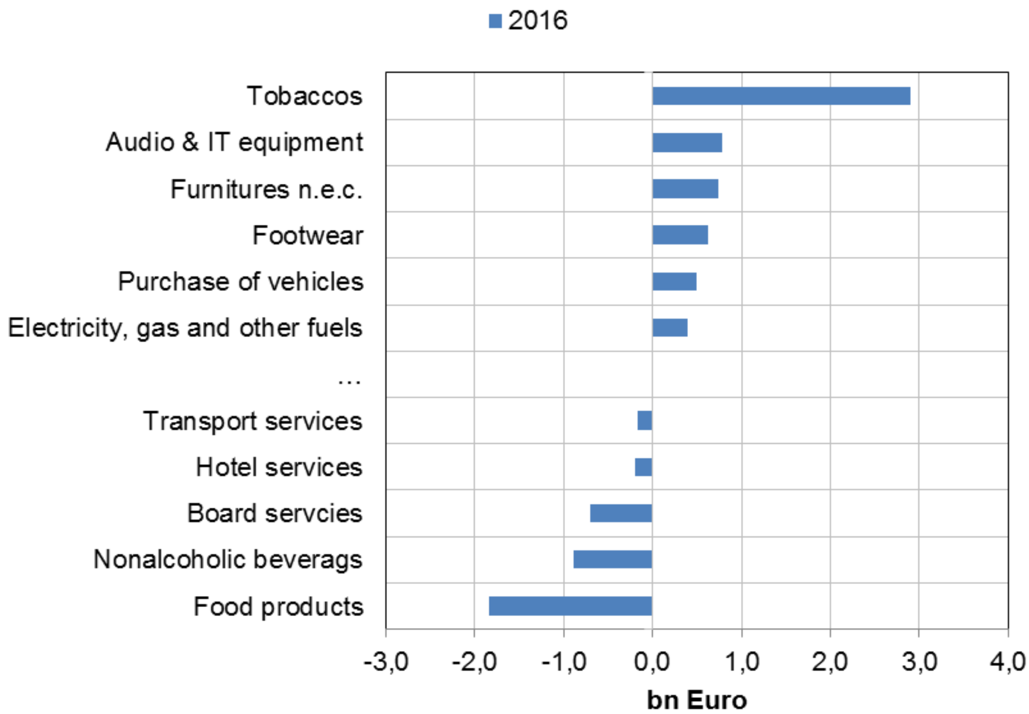
Figure 7: Simulation results on real GDP



The tranquillity of economic effects shown in simulation 3 is misleading as soon as the analysis leaves the aggregate level and looks in more detail on industrial levels. Figure 8 shows changes on structural level for real consumption expenditures of private households for the most effected products and services. Due to a uniform tax rate of 16.0, real consumption expenditures are increasing considerably for tobacco, audio & IT equipment, furniture, footwear or automobiles. All these consumption purposes profit from the introduction of a lower VAT rate. In contrast, food products and non-alcoholic beverages as well as transport, board and hotel services suffer the most from a uniform VAT rate of 16%. These consumption purposes are higher taxed than before and, hence, real private consumption expenditures are reduced due to the higher price effect. In the case of food products, real private consumption expenditures are almost 2 billion Euros lower to the baseline scenario. Food products have to face an eight per cent higher price level than in the baseline scenario. Consequently, real consumption expenditures for food products are declining. The price increase for food products is lower than the increase of the reduced tax rate implicates. This is the result of the firm's limited potential for transmitting tax rate increases immediately and in full to selling prices.

In the case of tobacco, real private consumption exceeds the level of the baseline scenario by three billion Euro in 2016. Negative price effects of up to 8% to the baseline scenario stimulate the purchase of tobacco.

Figure 8: Simulation 3: changes on structural level relative to baseline



The computed outcome stands in line with the qualitative results forwarded by Ismer et al. (2010) and SVR (2010). The recommended uniform VAT-rate of 16% in this paper is close to the recommendation of 16.5% put forward by the German Council of Economic Experts. The additional product tax revenue in a VAT-rate system from a uniform VAT-rate of 19% is similar in its volume level. Quantitative differences to the outcome of the other two publications are the result of the application of different simulation models and the usage of different databases. The analysis at hand uses – different to Ismer et al. (2010) and SVR (2010) – total analysis by applying the macro-econometric simulation model INFORGE.

6 CONCLUSIONS

This paper has investigated the impact of exogenous fiscal policy shocks on the German economy by applying the dynamic interindustry model INFORGE. The core of the paper concentrated on the modelling approach of taxes on products. After an overview over fiscal policy in theory and over empirical research on the analysis of fiscal policy shocks, the specification of the used modelling framework was outlined. In section 4 the relative importance of consumption taxes in the national accounts were outlined. Than, the setting of the historical database as well as the modelling of product taxes in INFORGE were described.

The modelling approach chosen in INFORGE has unbundled tax products in three different types of taxation and separated tax revenues in categories of goods and in components of total demand. This deep disaggregation of product taxes enables a distinct analysis of product taxes and their affects on consumption and production. This includes an analysis of tax policies and its affects on income and distribution of all components of total demand. More sophisticated analyses on the taxation of different products are possible with this kind of modelling.

In section 5, a simulation on value added tax rates were presented and discussed. The results of the simulation on three alternative regime shifts of the VAT-system display different results on aggregate level as well as on structural level. A revenue-neutral regime shift can be obtained with the introduction of a uniform VAT-rate of 16%. Other composition of VAT-rate changes calculated in this paper lead to a boost or to a contraction of the economic development in Germany. Whereas the VAT-system with a uniform VAT-rate of 16% shows neutrality on aggregate level; structural differences can be observed. The effects of price changes can be depicted on the level of goods and services that initiate real consumption adaptations. Examples of the consumption of food products and the purchase of vehicles demonstrated a negative and positive structural effect relative to the baseline scenario.

Nevertheless, further research for improving the current version of product tax modelling in INFORGE can be detected:

(i) Product taxes are in reality more complex than imaged in INFORGE. For instance the tax rate for tobacco differs depending whether cigarettes or tobacco shag are taxed. Other categories of products show similar complex features.

(ii) The current modelling framework lacks socio-economics factors, which limits the application of INFORGE with respect to specific research questions related to effects on different income groups or household types.

(iii) In its current version, INFORGE cannot account for efficiency gains due to a less complex reporting system for VAT collection.

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