

The German Business Tax Reform of 2000: A General Equilibrium Analysis

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Abstract. *In the year 2000 Germany enacted a major tax reform involving significant cuts in corporate and personal tax rates and a controversial change in the system of dividend taxation. This paper discusses the effects of the business tax reform on the German economy. The analysis is based on a detailed general equilibrium model of the OECD economy which is designed to illustrate the domestic and international effects of national tax policies. The simulations indicate that the German business tax reform will raise domestic economic activity and welfare, although the welfare gain will accrue disproportionately to households with a high ratio of property income to total income.*

1. THE GERMAN BUSINESS TAX REFORM: AN EXAMPLE OF INTERNATIONAL TAX COMPETITION?

Since the mid-1980s we have witnessed a series of sweeping tax reforms throughout the OECD area. Following years of political stalemate, Germany finally jumped on this bandwagon in the year 2000 by enacting a major tax reform, to be phased in between 2001 and 2005. One of the main goals of the reform was to make Germany a more attractive location for international investment. Like so many other recent tax reforms, the German reform has therefore been seen as part of the ongoing process of international tax competition.

In this paper I will ask whether the German tax reform is in fact a good example of international tax competition. Will the recent reform of capital income taxation succeed in attracting more capital and economic activity to Germany, and how will the welfare of German households be affected? These questions are of obvious importance for policy-makers in Germany as well as abroad. Indeed, if the German tax reform turns out to be a success, governments in other countries may be tempted to imitate the German policies, thereby offsetting some of Germany's competitive gains from the recent reform.

From a theoretical perspective the German tax reform is also interesting, because it involves a controversial change in the method of alleviating the economic double taxation of corporate dividends. This change was intended to make the tax system more neutral towards international capital flows. I will also consider whether this goal has in fact been realized.

Most theoretical papers on international capital taxation assume that there is a single type of internationally mobile capital which is subject to a single capital income tax rate. This extreme simplification may be useful for some analytical purposes, but it is inappropriate for evaluating the effects of a complex policy package like the German tax reform. In the real world the tax code distinguishes between foreign direct investment and foreign portfolio investment, between household investors and institutional investors, between different asset types like stocks, bonds and real estate, between current income and capital gains, between debt and equity, and so on. Furthermore, while some types of foreign investment income are taxed in the country of source, other income types are taxed in the investor's country of residence.

In this paper I present an applied general equilibrium model of the OECD economy which accounts for all of these complexities of the tax system. To my knowledge, no such model has previously been developed.¹ By allowing explicitly for the interdependencies between the German economy and the world economy in a general equilibrium framework, the model allows a consistent analysis of the effects of the German tax reform on international capital flows. In the first part of the paper I will describe the model. I will then review the German business tax reform and use the model to evaluate the effects of the various elements of the reform. Several writers have already analyzed various aspects of the German tax reform. As I proceed, I shall try to relate my findings to some of these previous analyses.

2. OECDTAX: A MODEL OF TAX POLICY IN THE OECD ECONOMY

2.1. General features of the model

The newly developed model which I will use to analyze the German business tax reform is called the OECDTAX model.² It includes a number of special features such as a detailed modeling of private portfolio composition, a distinction between foreign direct investment and foreign portfolio investment, the incorporation of a housing market, an explicit modeling of the financial sector, involuntary unemployment, endogenous corporate debt

1. The model of Grubert and Mutti (1994) does distinguish between foreign and domestic debt and equity, with both firms and households responding to different tax prices. However, the Grubert–Mutti model does not include the full portfolio choice embodied in the present model and is also simpler in most other dimensions.
2. A complete documentation of the model is provided in Sørensen (2001a).

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policies, international profit-shifting via transfer-pricing by multinational corporations, and explicit allowance for domestic and international tax evasion.

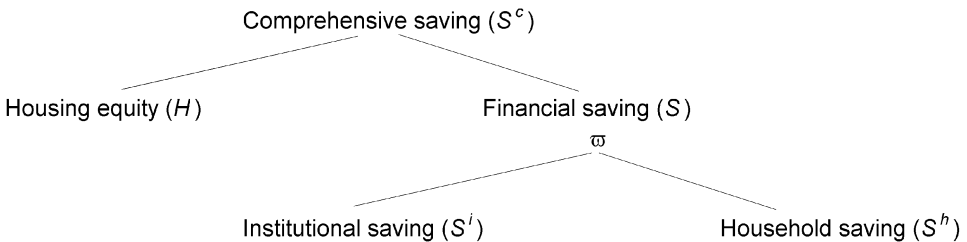
The OECDTAX model is static, describing a stationary long-run equilibrium. In each national economy firms combine internationally mobile capital with immobile labor to produce an internationally traded good which is a perfect substitute for foreign goods. The world economy is divided into two main regions called the European Union (EU) and the rest of the world (ROW). Both of the two regions consist of several countries. One country in the rest of the world is a tax haven representing those jurisdictions which have specialized in offering banking services and bank secrecy facilitating international tax evasion.

Capital is imperfectly mobile across nations, and the supply of capital to an individual country is an increasing function of the rate of return offered in that country. By parametrically varying the elasticity of substitution between assets invested in different countries, one can vary the degree of capital mobility and approximate a situation of perfect mobility. In particular, the model is designed to allow for a higher degree of capital mobility within the EU than between the EU and the rest of the world. The model can also account for the possibility that debt instruments issued in the various countries are closer substitutes than shares issued in the different jurisdictions.

2.2. Consumption, saving and portfolio allocation

Households in each country must choose between immediate and postponed consumption. Weighing the return to saving against the disutility of postponing consumption, the utility-maximizing consumer chooses to increase his supply of savings as the after-tax real rate of return increases.

Figure 1 illustrates the initial stages in the consumer's decision-making. Having optimized his total level of comprehensive saving, the consumer must allocate these funds between financial saving and investment in housing



ω = elasticity of substitution between institutional saving and household saving

Figure 1 Allocation of savings in the OECDTAX model: the initial stages

equity. This allocation will depend *inter alia* on his preference for housing consumption and on the user cost of owner-occupied housing. In the next step, the consumer must allocate his financial saving between institutional saving and so-called household saving. Household saving includes direct household purchases of stocks and debt instruments. Institutional saving includes financial saving channeled through pension funds and life insurance companies, plus pension savings via the banking and corporate sectors. For convenience, all interest-bearing assets are termed 'bonds', although they include bank deposits.

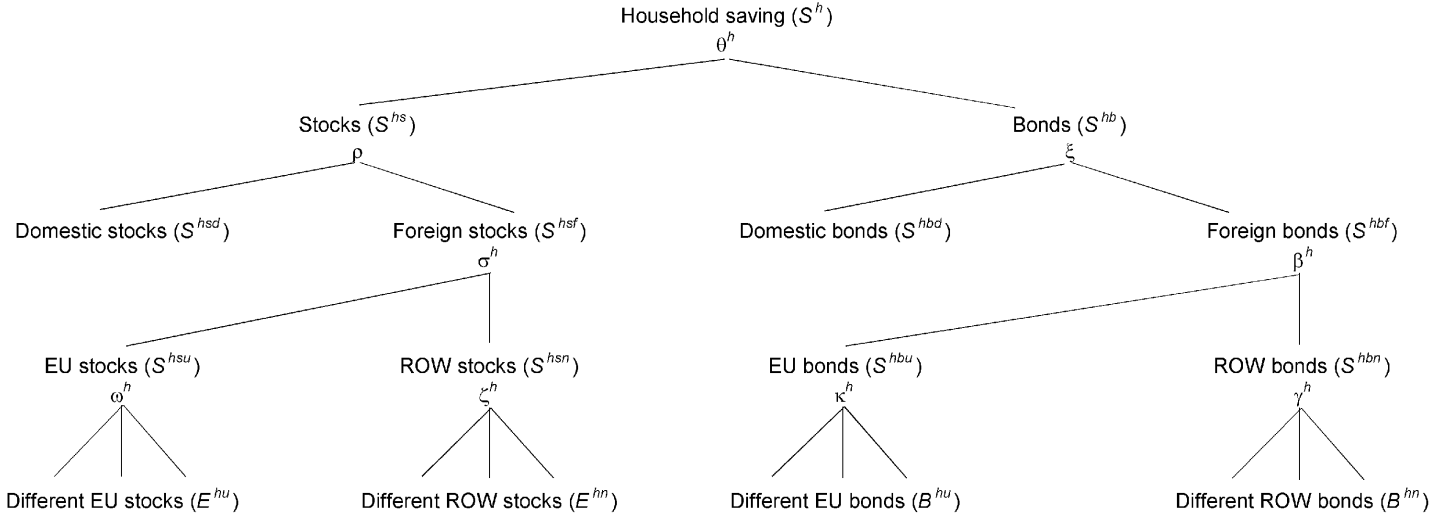
Figure 2 shows the subsequent stages of the consumer's decision process. Household financial saving must be allocated between stocks and bonds. Each of these two aggregates must then be allocated between domestic and foreign assets which in turn must be allocated between assets issued in the EU region and assets issued in the rest of the world. In the final stage, the portfolio is split into assets issued in the individual countries. The institutional savings are allocated across similar asset types in a like manner (see Figure 3).

The model specifies the various asset aggregates as CES functions of the individual asset types.³ By varying the substitution elasticities one can vary the degree of capital mobility in the different dimensions. To explain the observed 'home bias' in investor portfolios, it is assumed that portfolio investors incur additional information and transaction costs if they decide to invest abroad rather than at home.

2.3. *The business sector*

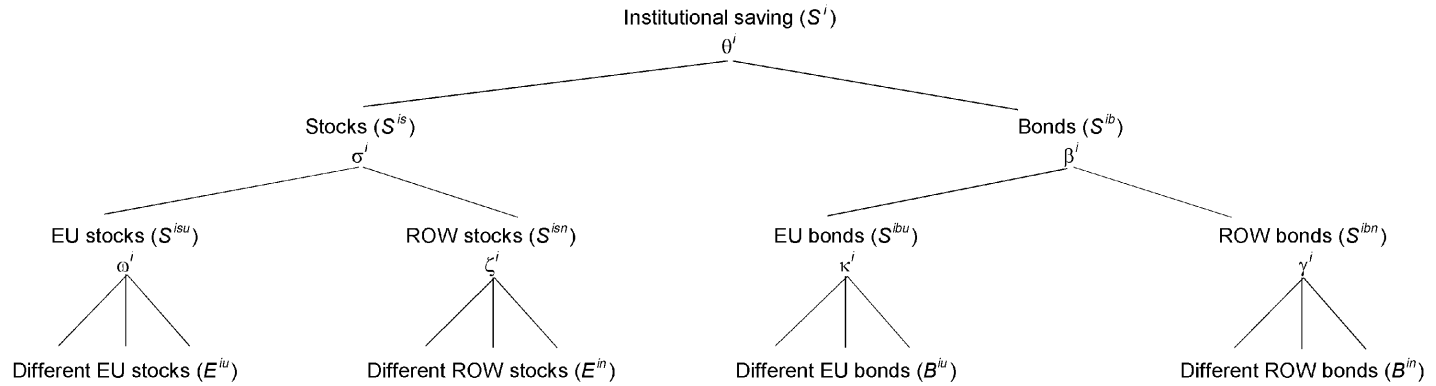
Figure 4 illustrates the structure of the business sector in the OECDTAX model. Each country is endowed with a fixed stock of intangible assets representing the level of human capital, technological and management know-how, etc. An exogenous fraction of these assets is allocated to a sector of multinational corporations which are headquartered in the country and which own foreign subsidiaries in all the other countries in the world economy. The remaining fraction of the country's intangible assets is allocated to domestic corporations with no foreign operations. Domestic corporations issue debt to domestic and foreign household and institutional investors and purchase labor services from domestic households. The equity shares in these firms are not traded internationally, but are held only by domestic households.

3. This specification implies that, if the various assets have identical after-tax returns, a diversified portfolio is more 'productive' in generating capital income than a portfolio concentrated on one or a few assets. In this way an incentive for portfolio diversification is created without explicitly introducing uncertainty, risk aversion and differences in risk characteristics across assets. Moreover, the incentive to switch between assets in response to changes in rates of return can be controlled via the choice of the substitution elasticities in the CES asset aggregates. Admittedly, this way of modeling imperfect capital mobility is somewhat ad hoc, but explicit introduction of uncertainty would make the model prohibitively complex, given all the institutional detail which is already included.



* Greek letters refer to asset substitution elasticities

Figure 2 The allocation of household saving



* Greek letters refer to asset substitution elasticities

Figure 3 The allocation of institutional saving

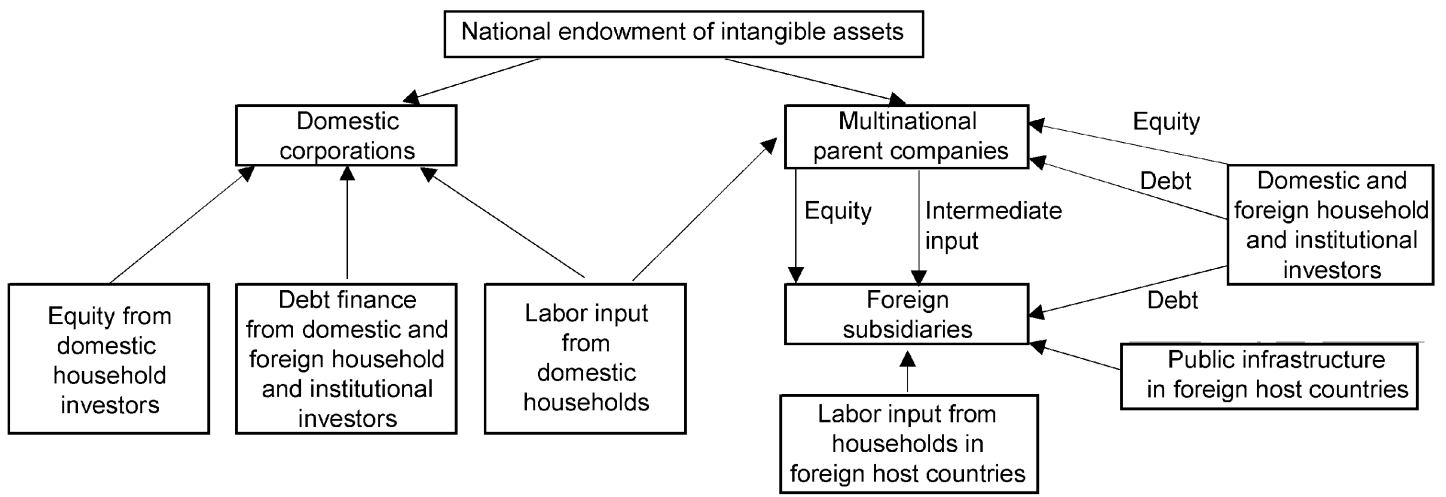


Figure 4 The business sector in the OECD TAX model

By contrast, multinational corporations issue shares as well as debt instruments to foreign as well as domestic household and institutional investors. The multinational parent companies inject equity into foreign subsidiaries, representing foreign direct investment. Subsidiaries also borrow in the host country capital market, and they hire labor in the foreign host country. In addition to equity, parent companies provide their foreign subsidiaries with intermediate inputs.

Factor demands and financial policies are determined by profit maximization. A firm's optimal level of debt is found by trading off the tax advantage of debt finance against the costs of financial distress which are assumed to increase with the debt–asset ratio. Moreover, multinational parent companies choose their transfer prices of intermediate inputs by trading off the organizational costs of distorted input prices against the tax advantage of shifting profits to foreign subsidiaries operating in low-tax countries.⁴

The Appendix provides more detail on the specification of the multinational sector in the model.

2.4. The labor market and the government

The labor market in each country is characterized by imperfect competition. Workers are organized in decentralized monopoly trade unions. Each union sets the real wage and the length of the working day for its sector with the purpose of maximizing the sum of utilities of its members, accounting for the fact that a higher wage rate will reduce the number of working hours demanded by employers.

Each national government levies indirect taxes on consumption and imposes direct taxes on labor income, interest income, corporate profits and the return on shares. In addition, the model includes various withholding taxes and a number of policy variables indicating the extent to which governments engage in international exchange of information to enforce residence-based income taxation. Public revenues are spent on public consumption, on unemployment benefits and on other transfers.

The model accounts for the various methods used by governments to alleviate the domestic and international double taxation of corporate-source income. The Appendix describes how the German system of domestic and international double tax relief has been modeled.

2.5. Equilibrium and calibration

A general equilibrium is established when households and trade unions maximize their utilities, firms maximize profits, and all national markets for bonds and stocks are clearing. Because of substitutability between securities

4. The quantitative importance of tax avoidance via transfer-pricing has been documented by Bartelsman and Beetsma (2000), among others.

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issued in different countries, the national asset markets are of course highly interdependent.

The model relies on simple functional forms to secure analytical tractability and to allow easy identification of the key structural parameters which determine the quantitative properties of the model. For example, by appropriate choice of the parameters in the household utility function it is possible to directly control the magnitude of the elasticities of saving and labor supply.

In its present calibration the model includes 24 OECD countries plus a jurisdiction representing the most important offshore tax havens in the world. Providing a meticulous calibration of the model is a challenging empirical research project in its own right. The calibration used in this paper must be seen as preliminary, because internationally comparable data on several of the variables in the model are not readily available. Most of the calibration relies on OECD national income accounts plus the OECD tax database for the year 2000 (see the Appendix for details).

Being static, the model does not illustrate the dynamics of capital stock adjustment and does not include adjustment costs. In this sense the model describes a long-run equilibrium. On the other hand, the model assumes that national endowments of intangible assets are fixed. In the very long run such assets may become mobile internationally, so the time horizon of the OECDTAX model may best be thought of as a medium to long run of, say, about ten years.

Table 1 shows the values of some selected parameters in the model. The substitution elasticities between the different asset types were chosen so as to generate a realistic pattern of portfolio composition. In particular, the substitution elasticities between domestic and foreign assets were chosen in combination with the international transactions cost parameters so as to reproduce the observed home bias in investor portfolios. The asset substitution elasticities imply a slightly higher degree of capital mobility inside than outside the European Union, and a slightly higher degree of substitutability between debt instruments than between stocks issued in the different countries. The elasticities imply a rather high degree of financial capital mobility and generate an equilibrium in which interest rates are fairly closely in line across the OECD countries, as we observe empirically.

The model includes parameters indicating the proportion of domestic and foreign source interest income and income from shares which escapes the household investor's personal income tax. Theorists either naively assume that all tax which is due is in fact paid, or they assume that all income from foreign portfolio investment escapes domestic tax, due to the inability of domestic tax authorities to monitor foreign source income. The OECDTAX model can accommodate both of these scenarios, but the truth is likely to be found somewhere in between these extremes. For assets held in the tax haven jurisdiction, the model does indeed assume that no residence-country tax can be levied. For Germany I assume pragmatically that one-fourth of household

Table 1 Calibration of some key parameters in the OECDTAX model^a

Elasticity of saving with respect to the after-tax rate of return	0.2
Elasticity of labor supply with respect to the after-tax wage rate	0.2
Wage share of value-added (average across countries)	0.64
Value of intermediate inputs relative to value of total output in foreign subsidiaries	0.1
Pure profit share of value-added	0.05
Annual rate of economic depreciation of business capital stock	10.1
Annual rate of economic depreciation of housing capital stock	0.02
Dividend payout ratio	0.333
Bank intermediation fee as a proportion of gross lending rate	0.05
Degree of home bias in household portfolios ^b	0.9
Degree of home bias in institutional investor portfolios ^b	0.8
Ratio of union wage to competitive wage level	1.2
Elasticity of substitution between housing assets and financial assets	1.0
Elasticity of substitution between household saving and institutional saving ($\bar{\omega}$)	1.0
Elasticity of substitution between stocks and bonds (θ)	4.0
Elasticity of substitution between EU bonds and ROW bonds (β)	4.0
Elasticity of substitution between different EU bonds (κ)	5.0
Elasticity of substitution between different ROW bonds (γ)	4.0
Elasticity of substitution between EU stocks and ROW stocks (σ)	3.5
Elasticity of substitution between different EU stocks (ω)	4.0
Elasticity of substitution between different ROW stocks (ζ)	3.5
Elasticity of substitution between foreign and domestic stocks held by households (ρ)	3.5
Elasticity of substitution between foreign and domestic bonds held by households (ξ)	4.0

^a The Greek letters refer to the substitution elasticities indicated in Figures 1 through 3.

^b A degree of home bias equal to 0.9 (0.8) means that investors will invest 90% (80%) of their wealth in domestic assets and the remaining fraction in foreign assets if the after-tax return is the same at home and abroad.

portfolio income from foreign countries (outside the tax haven) and one-half of interest income from domestic sources is subject to personal income tax. The remaining fractions of portfolio income are assumed to escape personal tax, either because of evasion or because they fall below the exemption level for capital income. For other countries it also assumed that enforcement of personal tax on foreign portfolio income is less effective than the enforcement of tax on domestic source portfolio income.⁵ In section 4.7 below I shall

5. The model can account for the fact that automatic reporting systems for domestic source interest income and international exchange of information among tax authorities increase the effectiveness of tax enforcement in some countries. The simulations in this paper assume that the authorities are able to tax all of the domestic source dividend income of households, due to the monitoring of corporations done by external accountants and tax collectors, and due to the incentive under the old tax system to report dividend income to claim imputation tax credit.

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Table 2 The initial equilibrium in the OECDTAX model^a (population-weighted averages across countries)

	Germany	OECD average ^b
Stock of outward FDI relative to domestic stock of business capital	0.12	0.08
Stock of inward FDI relative to domestic stock of business capital	0.02	0.07
Stock of outward portfolio investment relative to domestic stock of business capital	0.09	0.14
Stock of inward portfolio investment relative to domestic stock of business capital	0.17	0.14
Residential capital stock relative to total domestic capital stock	0.58	0.60
Ratio of household saving to total financial saving	0.96	0.87
Weight of shares in household portfolios	0.30	0.21
Proportion of interest-bearing household assets held in tax haven jurisdictions	0.01	0.01
Weight of shares in institutional investor portfolios	0.13	0.18
Debt–asset ratio of domestic corporations	0.66	0.64
Debt–asset ratio of multinational parent companies	0.45	0.44
Unemployment rate	0.08	0.07

^a Based on the calibration given in Table 1.

^b Population-weighted averages.

illustrate the sensitivity of the simulation results to these assumptions in the case of Germany.

Table 2 shows some key ratios indicating the importance of various types of investment in the initial equilibrium implied by the calibration in Table 1. The figures in the second column of Table 2 are population-weighted averages across the 24 OECD countries included in the model. The ratios of foreign direct investment to total business investment in the model match quite well with the corresponding empirical ratios recorded in the OECD statistics. The fact that inward portfolio investment only accounts for a minor part of total business finance reflects the well-known home bias in investor portfolios. The initial equilibrium also reproduces the empirical facts that inward FDI and institutional saving are relatively unimportant in Germany.⁶

I have now sketched my framework for analyzing the German business tax reform. Before putting the model to use, let us quickly review the most important elements of the reform.

6. When judging the plausibility of the rather low proportion of interest-bearing household assets held in tax haven jurisdictions, it must be kept in mind that ‘tax havens’ in this context do not include countries like Luxembourg and Switzerland and other ‘ordinary’ countries with bank secrecy rules.

3. THE GERMAN BUSINESS TAX REFORM

Table 3 summarizes the main elements of the German business tax reform which started to take effect in 2001 and which will be fully phased in by 2005.⁷ The table shows the tax rules which will prevail in 2005. In addition to the elements mentioned in Table 3, the reform package also includes planned cuts in the average tax rate on labor income, through a combination of lower personal tax rates and an increase in the basic allowance. These planned cuts in the tax burden on labor are not incorporated in the present analysis, since it is not clear how the substantial revenue loss from this part of the tax reform is going to be financed.

The business tax reform involves significant changes in the corporation tax as well as the personal tax on capital income (dividends, interest and capital gains). First of all, the statutory corporate tax rates on retained and distributed profits will be aligned at the common level of 38.6 per cent for a company subject to the average level of the local business tax. With this alignment Germany abandons her time-honored split-rate corporate tax system and implements a 13.2 percentage point cut in the tax rate on retained corporate earnings. At the same time the reform broadens the corporate tax base by reducing the tax depreciation rates for fixed business assets. In addition, the previous imputation system of dividend tax relief is replaced by the so-called half-income system by which only half of the shareholder's dividend income is included in taxable personal income. As a parallel, only 50 per cent of capital gains on shares representing a substantial interest will be included in taxable income, but the threshold defining a substantial interest is lowered from 10 per cent to 1 per cent.

Despite the drop in marginal personal tax rates, the top marginal personal rate of 44.3 per cent will remain above the new corporate tax rate of 38.6 per cent. This implies a tax advantage for profits accumulated within a corporation compared to profits accumulated within an unincorporated firm. To offset this advantage, the owners of unincorporated firms are allowed to deduct a standardized amount of the local trade tax from their personal income tax liability. This will not ensure complete tax neutrality between incorporated and unincorporated firms, but it is not clear which organizational form will be tax-favored over the other. As shown by Homburg (2000), this will depend on the investment horizon of the entrepreneur. In the analysis below I will not try to quantify the distortionary effects of the different tax treatment of the corporate and the non-corporate sectors.

Another reform measure deserving attention is the abolition of corporation tax on realized capital gains on a parent company's shares in a domestic subsidiary.⁸ This measure, discussed at length by Keen (2000, section D), may

7. A quick overview of the reform can be found in Bundesministerium der Finanz (2001). Homburg (2000), Keen (2000) and Schreiber (2000) provide more details on the tax reform.

8. Gains on holdings of shares in foreign subsidiaries were already exempt prior to the reform.

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Table 3 Main elements of the German business tax reform^a

1. Reduction of statutory corporate tax rates^b

- The tax rate on retained corporate income is reduced from 51.8% to 38.6%
- The tax rate on distributed corporate income is reduced from 43.0% to 38.6%

2. Reduction of depreciation allowances

- The declining-balance tax depreciation rate for movable assets is reduced from 30% to 20%
- The straight-line tax depreciation rate for business buildings is reduced from 4% to 3%
- Official depreciation rate tables are to be based on more realistic useful life periods

3. Reform of the method of corporate–personal tax integration

- The imputation method of dividend tax relief is abolished
- Instead, only 50% of dividends and taxable capital gains on shares are included in the shareholder's taxable personal income
- The threshold defining a substantial shareholding (triggering capital gains tax) is lowered from 10% to 1%

4. Reduction of statutory tax rates on capital income

- The top marginal personal tax rate on capital income is lowered from 53.8% to 44.3%. The basic marginal personal income tax rate will fall from 24.2% to 15.8%
- The rate of dividend withholding tax is reduced from 25% to 20%

5. Other reform measures

- Introduction of credit for standardized amount of local business tax (*Gewerbesteuer*) against the personal tax liability of owners of unincorporated firms
 - Abolition of corporate income tax on capital gains on a parent company's shares in a subsidiary
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^a Changes between 2000 and 2005 when the reform is fully phased in. Wherever relevant, the tax rates include the solidarity surcharge of 5.5%.

^b Including the local business tax (*Gewerbesteuer*), based on an average multiplier (*Hebesatz*) of 398%.

be expected to facilitate corporate restructuring, but the OECDTAX model is not designed to capture such effects.

4. THE EFFECTS OF THE TAX REFORM ON THE GERMAN ECONOMY

In Table 4 the OECDTAX model has been used to simulate the effects on the German economy of the reform elements 1 through 4 listed in Table 3, as well as the effects of the entire business tax reform. Table 4 shows percentage changes relative to the initial equilibrium. In the first four rows of Table 4 each of the four reform elements described in Table 3 are assumed to be

Table 4 Domestic effects of the German business tax reform (changes in per cent)

Reform element	Stock of business capital	Inward FDI	Inward portfolio investment	Outward FDI	Outward portfolio investment	Inward profit shifting ^a	GDP	Welfare effects		
								Welfare gain in % of initial GDP	Welfare gain due to change in property income ^a	Welfare gain per unit of revenue lost
1. Reduction of corporate tax rates	5.4	38.2	4.0	-8.5	-4.1	0.4	1.8	0.60	0.58	1.64
2. Reduction of depreciation allowances	-4.8	-12.7	-5.0	3.9	3.2	0.0	-1.5	-0.21	-0.13	0.72
3. Reform of corporate-personal tax integration	-0.9	3.6	-0.4	-0.3	2.8	0.0	-0.3	-0.10	-0.05	n.a. ^b
4. Reduction of personal tax rates on capital income	1.1	-4.2	-6.1	3.0	-1.8	0.0	0.5	0.30	0.56	1.01
Total business tax reform = 1 + 2 + 3 + 4	1.5	26.5	-5.8	-11.0	1.0	0.4	0.8	0.70	0.86	2.98

Notes: Due to non-linearities, the effects of the individual reform elements do not necessarily add up to the effect of the total reform.

^a Change in per cent of initial GDP.

^b This reform element will have almost no effect on public revenue, assuming that the initial personal tax rates are maintained. See footnote 12.

Source: Simulations with the OECDTAX model.

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implemented in isolation, with all the other rules of the old tax system being maintained. In all of the policy experiments in Table 4, I assume that any change in government revenue is reflected in a corresponding change in (lump-sum) transfer payments to German households. According to the model, the total business tax reform will result in a modest revenue loss of 0.24 per cent of the initial GDP, once all the general equilibrium effects are accounted for. The simulation of the total reform thus assumes that this revenue loss will be financed by a future cut in public transfers of equal present value.

When evaluating the rather large percentage changes in inward FDI recorded in Table 4, it must be kept in mind that the initial stock of inward FDI in Germany is quite small, as shown in Table 3. Even a modest absolute change in inward FDI will therefore translate into a fairly large percentage change.

I will now discuss the effects of each of the elements of the tax reform on investment and economic activity in Germany. In a subsequent section, I shall address the effects on welfare and distribution.

4.1. The cut in statutory corporate tax rates

A priori, the effects of the cut in the statutory tax rates on retained and distributed corporate profits are not obvious. To see this, it is useful to consider a simplified formula for the cost of capital. For a domestic corporation maximizing profits in a static setting, the required gross rate of return c on the marginal unit of investment will be given by

$$c = di + (1 - d)\rho + \tau(c - \alpha di - \hat{\delta}) + \delta \iff$$

$$c = \frac{di(1 - \alpha\tau) + (1 - d)\rho + \delta - \tau\hat{\delta}}{1 - \tau} \quad (1)$$

where τ is the statutory corporate tax rate, d is the fraction of marginal investment spending which is financed by debt, i is the interest rate, ρ is the required rate of return on shares (the cost of equity finance), α is the fraction of interest expenses which is deductible from the corporate tax base, δ is the true (exponential) rate of economic depreciation, and $\hat{\delta}$ is the rate of depreciation allowed for tax purposes. In a German context the parameter τ must be interpreted as a weighted average of the tax rates on retained and distributed profits, with the weights reflecting the relative importance of retentions and new equity for the financing of new investment. Equation (1) states that the pre-tax rate of return c must cover the costs of debt and equity finance $di + (1 - d)\rho$, plus the tax bill $\tau(c - \alpha di - \hat{\delta})$, plus the true rate of depreciation. On the simplifying assumption that d is independent of τ , it can be shown from (1) that

$$\frac{\partial c}{\partial \tau} \geq 0 \quad \text{for} \quad di(1 - \alpha) + (1 - d)\rho \geq \hat{\delta} - \delta \quad (2)$$

This relationship shows that if a large fraction of the return to the marginal investment is shielded from tax through the use of debt finance, i.e. if α and d are close to one, *and* if the tax code allows strongly accelerated depreciation so that $\hat{\delta}$ is significantly above δ , it is possible that a cut in the statutory corporate tax rate will *increase* the required rate of return, thereby reducing investment. This is the well-known *taxation paradox* elaborated by Sinn (1987, pp. 145–153). The reason for the paradox is that a lower corporate tax rate reduces the value of the tax subsidy implied by accelerated depreciation.

However, in the OECDTAX model the conditions for the taxation paradox are not met, since a substantial fraction of the marginal investment is assumed to be financed by equity which is not shielded from tax through deductibility of the cost of finance. Even though the cut in statutory corporate tax rates reduces the firm's tax savings from accelerated depreciation, the net effect of the lower tax rates is a fall in the tax burden on the marginal investment. From Table 4 we see that this will stimulate business investment in Germany, including inward foreign direct investment undertaken by foreign multinational companies. In contrast, the tax cut will *not* benefit outward direct investment from Germany, since foreign source corporate income is almost fully exempt from German corporation tax. Indeed, we see from the first row of Table 4 that outward direct investment will even fall. The main reason is that the higher corporate investment in Germany implies an increase in the stock of equity in German companies. To induce investors to absorb this increase in outstanding equity in their portfolios, the return on German shares has to go up. This in turn hampers outward direct investment by raising the cost of equity finance for German multinationals.

The increased demand for investment finance from German companies drives up the return on German bonds as well as shares, leading to increased inward portfolio investment and reduced outward portfolio investment. The lower statutory corporate tax rate also induces multinational corporations to shift a greater part of their global profits into Germany via transfer pricing, thereby boosting German corporate tax revenues.

The total effect of the reduction of corporate tax rates is an estimated 1.8 per cent increase in German GDP of which 0.4 per cent is accounted for by the shifting of profits into Germany.

4.2. *The cut in depreciation allowances*

Part of the revenue cost of the lower tax rates in Germany is supposed to be recouped via the reduction in the maximum rates of depreciation allowed for tax purposes. Calculated as a weighted average across machinery and buildings, the tax reform reduces the depreciation allowances for fixed business assets by approximately 30 per cent. However, tangible business assets also include inventories for which there is no change in valuation rules. According to OECD (1991, p. 455), inventories account for slightly less than 30 per cent of total tangible business assets in Germany. On this basis, the German tax reform can

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be estimated to reduce the depreciation rate for tangible assets by roughly 20 per cent, measured as an average across machinery, buildings and inventories. The simulation in the second row of Table 4 therefore assumes that the tax reform will cut the average depreciation rate by one-fifth, and that depreciation for tax purposes will be roughly in line with true economic depreciation after the reform.

Whereas the cut in the corporate tax rate reduces the cost of corporate capital, the reduction of depreciation allowances works in the opposite direction, as indicated by equation (1). This makes Germany a less attractive location for investment and drives capital out of the country. As a consequence, we observe a drop in German economic activity.

It should be noted that the figures in the second row of Table 4 may overestimate the effects of the change in depreciation rates. The reason is that, in practice, a substantial number of firms are unable to take full advantage of depreciation allowances because they occasionally have negative taxable profits.

4.3. *The reform of corporate–personal tax integration*

To evaluate the effects of the German reform of dividend taxation, we must enter one of the most controversial areas in the theory of taxation.⁹ Simple theoretical models typically assume that shares and bonds are perfect substitutes. The cost of equity finance for corporations is then determined by the marginal shareholder's arbitrage behavior which drives the after-tax return on shares into equality with the after-tax return on bonds. Hence it becomes crucial to determine the identity and tax status of the marginal shareholder. Is he a private household investor or a tax-exempt institutional investor? Is he a domestic or a foreign resident? The answer is obviously important for evaluating the effects of an imputation system like the German system which only granted dividend tax credits to domestic residents with a positive domestic tax liability.

In the OECDTAX model the problem of singling out *the* marginal shareholder does not arise, since there is no single investor type whose arbitrage behavior is all-decisive for the determination of stock prices. The reason is that domestic shares are *imperfect* substitutes for other assets. This means that all investor groups will wish to hold some amount of all asset types in order to diversify their portfolios. All investor groups will therefore have some influence on the required return on domestic shares, but no single group will have an all-dominant influence. In particular, the domestic stock market effect of the German dividend tax reform will be dampened by the fact that the reform only affects the dividend tax treatment of domestic household investors, leaving the tax status of foreign and institutional investors unaffected.

9. See Sørensen (1995) for an overview.

Another controversial issue in the theory of corporate taxation is whether the company's marginal source of finance is debt, retained earnings or new share issues. Most analysts agree that capital market imperfections often require firms to use some amount of equity finance at the margin. But when evaluating the impact of the tax system on the cost of equity finance, it is important whether equity takes the form of retained profits or new share issues. When investors inject new equity into the firm, they cannot take out any future dividends on the injected funds without subjecting themselves to dividend tax. In this case any double taxation of dividends will raise the required pre-tax rate of return and discourage corporate investment. By contrast, the dividend tax does *not* affect the required return on investment financed by retained profits, because the equity is already 'trapped' in the firm so that dividend tax cannot be avoided whether profits are paid out today or tomorrow. Instead, it is the possible tax on the investor's capital gains on shares which will determine his required return on investment financed by retained earnings.

The way to reconcile these conflicting views of the importance of dividend taxation – which specialists will easily recognize as the so-called 'old' versus 'new' views – is to acknowledge that well-established mature firms will typically be able to use retained earnings as the dominant source of equity finance, whereas newly established and immature firms will often have to rely on new share issues. Even though new equity only accounts for a small fraction of equity finance in the aggregate, double taxation of dividends can have a strong distortionary impact on the cost of capital for immature firms. Indeed, the distortion can be even stronger than the effect predicted by the traditional Harberger view of dividend taxation, as shown by Sinn (1991). Since the essence of capitalism is Schumpeter's process of creative destruction whereby new innovating firms continually conquer market shares from established firms, any long-run analysis has to allow for some distortionary effect of dividend taxation. The OECDTAX model does so in a pragmatic way by assuming that one-third of the return to corporate equity gets taxed as dividends, whereas two-thirds get taxed as retained earnings. A similar assumption was made in a recent OECD report on the taxation of savings (OECD, 1994).

With all this in mind, we are ready to turn to the third row in Table 4 which shows the isolated effects of the switch from the imputation system of dividend tax relief to the so-called half-income system. Under the imputation system resident household shareholders received a credit against their personal tax liability for the German corporation tax already paid on the profits underlying their dividends. Importantly, dividends paid out of foreign source income did not qualify for dividend tax credit because the underlying profits do not bear German corporation tax. Thus the German imputation system discriminated against foreign source income, and this was one declared reason why it was abolished. Moreover, institutional investors and foreign investors were generally not eligible for imputation tax credits because they do not pay

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German tax.¹⁰ Under the new half-income system, double taxation is relieved by including only 50 per cent of the dividend in the shareholder's taxable personal income. This rule is applied to foreign source as well as domestic source dividends, so the half-income system eliminates the tax discrimination against foreign income.

Whereas the previous German imputation system implied full alleviation of the double taxation of domestic source dividends, the half-income system leads to some amount of double taxation by raising the net personal tax liability on dividend income from domestic sources. In principle, the virtue of the half-income system is that it imposes the same tax rate on dividends from foreign and domestic sources. However, in practice the lack of effective information exchange between German and foreign tax authorities gives strong reason to believe that most foreign source dividends accruing to German portfolio investors escapes German personal tax anyway. At least this is the assumption made in the OECDTAX model. Hence the increase in the net personal tax rate on dividend income falls mostly on domestic source dividends, inducing German household investors to increase their holdings of foreign shares at the expense of their holdings of German shares. In addition, the lower after-tax return to German shareholders reduces household financial saving. For both of these reasons, the supply of funds to the German stock market goes down, thereby driving up the cost of equity finance for domestic firms as well as for German multinationals. As a consequence, the third row of Table 4 shows a fall in the domestic capital stock and a slight drop in outbound direct investment.

At first glance the recorded increase in *inbound* direct investment may seem surprising. It is explained by two factors. First, the lower investment and output in domestically owned firms reduces the German wage level by driving down the demand for labor. Second, the higher dividend tax induces German households to reallocate their portfolios towards bonds which slightly depresses the German interest rate. These drops in German factor costs increase the incentive for foreign multinationals to invest in Germany, since foreign firms do not suffer from the increase in the cost of equity finance which is hurting German firms.

The fall in the German interest rate also helps to explain the slight fall in inward portfolio investment. This minimal fall is the net result of a drop in foreign holdings of German bonds and an increase in foreign holdings of German shares, as German investors sell off some of their domestic shares to foreigners.

Under the imputation system, distributed foreign source profits of German multinationals did not qualify for dividend tax credit. The half-income system eliminates this discrimination against income from foreign direct investment since it imposes the same personal tax rate on all dividends, regardless of their source. Obviously this should tend to stimulate outbound direct investment.

10. As an exception to this general rule, Germany did grant imputation credits to French holders of shares in German firms, as part of the tax treaty between Germany and France.

However, in the OECDTAX model this effect is too small to prevent a slight fall in outward FDI. The reason is that the bulk of the foreign profits of German multinationals is assumed to be retained and reinvested in the foreign subsidiaries and that only a fraction of repatriated profits are paid out to German shareholders. Both of these factors reduce the quantitative importance of the tax discrimination against foreign profits under the imputation system.

Because it assumes an exogenous dividend payout ratio, the OECDTAX model does not capture all of the possible effects of the German tax reform on corporate financing and investment strategies. The elimination of the tax discrimination against distribution of foreign source dividends increases the incentive for German multinationals to distribute their foreign source income rather than reinvesting it in the domestic economy. Since the tax reform makes domestic reinvestment of foreign profits relatively less attractive, Eggert and Weichenrieder (2001) have recently suggested that the reform will tend to increase the required return on the *domestic* investments of German multinationals.¹¹ As we have seen, the OECDTAX model makes the same prediction, although for different reasons. Obviously the two analyses are not mutually exclusive.

I have spent some time discussing the effect of the German dividend tax reform, since this is the most controversial and theoretically challenging part of the total reform. My analysis suggests that the reform will cause a slight drop in domestic investment by increasing the tax burden on dividend income from German firms. However, perhaps the most important message is that the quantitative effect of this part of the tax reform is likely to be small. The main reason is that the German stock market is open to foreign investors so that changes in the tax treatment of German shareholders can have only a limited impact on the cost of equity finance for German corporations. This point has also been stressed in recent contributions by Fuest and Huber (2000) and Dickescheid (2001).

4.4. The cut in personal tax rates on capital income

The fourth element in the German business tax reform is the cut in marginal personal tax rates on income from shares and debt instruments. In the fourth row of Table 4 it is assumed that this tax cut is implemented while maintaining the imputation system. Since capital gains on shares are mostly exempt from personal tax in Germany, the cut in marginal personal tax rates on capital income benefits interest income more than it benefits income from shares. *Ceteris paribus* this tends to raise the required pre-tax rate of return on shares. However, because international information exchange between Germany and her partners is far from fully effective, the foreign source capital income of German households largely escapes domestic personal tax in the OECDTAX model. Hence the cut in personal tax rates mainly serves to raise the after-tax

11. This hypothesis draws on earlier theoretical work by Weichenrieder (1998).

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return to *domestic* assets, leading to less outward portfolio investment. The resulting increase in the demand for German securities drives down the pre-tax return to German stocks as well as bonds, thereby discouraging inward foreign portfolio investment. The lower required pre-tax return on German shares and bonds reduces the cost of finance for German companies. This generates more domestic investment as well as more outward foreign direct investment. The larger domestic capital stock causes an increase in GDP. The fall in inbound direct investment is the net result of offsetting tendencies. On the one hand, the lower German interest rate tends to stimulate inward FDI (which is partly financed by debt issues in Germany). On the other hand, the higher activity level drives up German wage costs. The latter negative effect on inbound FDI turns out to dominate.

4.5. The total business tax reform

The fifth row shows the combined effect of all the above four elements of the German business tax reform. Because the various elements interact, the total effects cannot be found by simply adding up the figures in the previous four rows. As we have seen, the cuts in corporate and personal tax rates on capital income will tend to increase investment and economic activity in Germany, but the cut in depreciation allowances and the dividend tax reform will work in the opposite direction. According to the model, the net effect of all these components of the business tax reform will be an increase in domestic and inward foreign investment in Germany and an associated 0.8 per cent increase in German GDP.

4.6. Effects on welfare and distribution

Presumably the ultimate goal of the German business tax reform was to raise economic efficiency and consumer welfare in Germany. The last three columns in Table 4 report the simulated effects on aggregate consumer welfare. Because the initial level of activity is inefficiently low due to tax and labor market distortions, we see that reform elements which stimulate the level of investment and GDP will also tend to raise consumer welfare, and vice versa. The model predicts that consumers will obtain a welfare gain of 0.86 per cent of GDP due to a change in net property income (consisting of the normal after-tax return to saving plus pure profits). At the same time consumers will suffer a loss in transfer incomes because of the need to cut public spending to finance the tax reform. As a result, the net welfare gain from the total business tax reform will only amount to 0.7 per cent of GDP. These figures suggest that the main beneficiaries of the business tax reform will be individuals with a high ratio of property income to other income over the life cycle.

The last column in Table 4 shows the welfare gain (loss) per unit of tax revenue lost (gained). This may be seen as a general equilibrium measure of the marginal cost of public funds, allowing for all of the repercussion effects of the

various tax instruments (or of the tax reform as a whole). The figures indicate that, in welfare terms, cutting depreciation allowances is a relatively 'cheap' way of raising public revenue. Overall, the OECDTAX model suggests that the German business tax reform will pay off very well in terms of improving economic efficiency, since the total efficiency gain will be almost three times as large as the amount of public revenue lost.¹²

While Sinn and Scholten (1999) and Keen (2000, section B) agree that the business tax reform will raise economic welfare, they argue that it will do so mainly by reducing the inefficient tax subsidies to investment in machinery and buildings implied by accelerated depreciation. In other words, these authors estimate that the business tax reform will tend to *increase* the cost of capital and *reduce* real business investment in Germany, in contrast to the simulation results presented above.

The contrasting predictions may be explained by three factors. First of all, the depreciation rate in the OECDTAX model is a weighted average of the rates for several asset types, including some for which there is no change in depreciation allowances. Measured across all asset types, the business tax reform implies a smaller cut in depreciation allowances than the cuts for machinery and buildings considered by Sinn and Scholten (1999) and Keen (2000). In line with recent estimates by the European Commission (2001, pp. 102–109) which include assets like intangibles and inventories as well as machinery and equipment, the OECDTAX model therefore predicts that the impact of the cut in depreciation allowances on the average cost of capital for domestic firms will be outweighed by the impact of the fall in statutory corporate tax rates (still, there is hardly any doubt that the tax reform will increase the cost of capital for some types of investment and that this will help to raise economic efficiency by weeding out low-productive investment). Second, the OECDTAX model accounts for the impact of the tax reform on inward foreign direct investment. As Keen agrees (2000, pp. 11–14), the tax reform increases the incentive for inward FDI in Germany. Third, in contrast to the partial equilibrium studies mentioned above, the OECDTAX model allows for the fact that the business tax reform will drive down the equilibrium rates of return on German stocks and bonds, thereby stimulating domestic investment.

As a caveat to the welfare analysis presented here, it must be recalled that international capital flows do not generate any terms-of-trade effects in the OECDTAX model, since the goods produced in the different countries are assumed to be perfect substitutes. If commodities are imperfect substitutes, capital flows and the associated changes in trade balances may be accompanied

12. According to the model, a switch from the imputation system to the half-income system of dividend taxation under the high tax rates on dividend income prevailing before the reform would hardly have generated any additional revenue, because households would have substituted away from stockholding towards holdings of domestic and foreign bonds, towards increased institutional saving and towards increased saving in home equity. With an almost zero revenue gain, the welfare loss per unit of revenue gained would have been very high and very uncertain, and hence the figure is not reported in Table 4.

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by relative price changes which can have important welfare effects. However, in the OECDTAX model a substantial part of the capital flows generated by the German tax reform takes the form of foreign direct investment, where a multinational corporation moves part of its production from one country to another. Since such FDI merely relocates the production of a given commodity without changing its relative supply in the world market, it is not likely to be associated with significant relative price changes.¹³

4.7. Sensitivity analysis

As already mentioned, the effects of the new German 'half-income' system for taxing shareholder income will depend on the marginal source of corporate equity finance. If equity takes the form of new share issues, the return will be taxed as dividends. If equity is instead mobilized via retained profits, the return to the shareholder will be taxed as a capital gain on the shares. The benchmark scenario presented above assumes that, on average, one-third of the return to shareholding gets taxed as dividends. Table 5 shows the effects of changing this assumption by varying the assumed dividend payout ratio of corporations. The first row restates the results of the benchmark scenario with a dividend payout ratio of one-third. In the second row the dividend payout ratio of all German corporations (including German-owned foreign subsidiaries) is assumed to be only 10 per cent, reflecting the 'new view' of dividend taxation according to which retained profit is the dominant source of equity finance. By contrast, the third row assumes that one-half of all after-tax corporate profits is distributed to shareholders so that dividend taxation becomes much more important for the after-tax return on shares, in accordance with the so-called 'old' view. We see that the business tax reform will be more expansionary (and hence will generate a larger welfare gain), the lower the dividend payout ratio. With a lower payout ratio, the increase in the effective tax burden on dividends implied by the switch from imputation to the half-income system has a smaller impact on the marginal after-tax return to equity and hence a smaller impact on the cost of corporate finance. Even so, we see that the total business tax reform will have a non-negligible positive effect on activity and welfare in all scenarios.

The benchmark scenario assumes that the tax reform will reduce the average rate of depreciation for tax purposes by about 20 per cent, measured across all tangible assets. However, the average cut in depreciation allowances for *fixed* assets will be larger, and it is uncertain how heavily these assets weigh in the

13. The model implies that, because the personal tax cuts will stimulate savings whereas the stimulus to investment will be dampened by the cut in depreciation allowances, the business tax reform will increase German net foreign asset income by about 0.3 per cent of initial GDP. In the new general equilibrium, this is matched by a similar deterioration of the German trade balance, to maintain current account balance. Thus, despite the absence of terms-of-trade effects, the OECDTAX model does not seem to generate implausibly large changes in trade balances.

Table 5 Domestic effects of the German business tax reform: sensitivity analysis (changes in per cent)

	Stock of business capital	GDP	Welfare gain in per cent of initial GDP	Welfare gain per unit of revenue lost
Benchmark scenario ^a	1.5	0.8	0.7	3.0
Dividend payout ratio = 0.1	2.7	1.2	0.9	4.9
Dividend payout ratio = 0.5	0.6	0.5	0.6	2.4
Reduction of average depreciation rate = 25%	0.1	0.4	0.6	4.4
Ineffective enforcement of personal tax on capital income ^b	1.3	0.7	0.6	11.5
More effective enforcement of personal tax on capital income ^c	1.6	1.0	1.0	10.3

^a Dividend payout ratio = 0.333; reduction of average depreciation rate = 20%; German personal tax enforced on 100% of domestic source dividend income, on 50% of domestic source interest income and on 25% of foreign source interest and dividend income.

^b German personal tax enforced on 25% of domestic source interest income and on 0% of foreign source interest and dividend income.

^c German personal tax enforced on 75% of domestic source interest income and on 50% of foreign source interest and dividend income.

Source: Simulations with the OECDTAX model.

total stock of tangible business assets. The fourth row of Table 5 therefore assumes that the tax reform reduces the average depreciation allowance by one-fourth rather than by one-fifth. The simulation still assumes that the tax reform will bring depreciation for tax purposes in line with true economic depreciation, as intended by policy-makers. Hence the implicit assumption in the fourth row of Table 5 is that the initial average depreciation rate for tax purposes is higher than in the benchmark scenario. On these assumptions we see that the positive effects on real investment of the fall in statutory tax rates will be almost fully neutralized by the cut in depreciation allowances. This means that the recorded rise in German GDP will be generated almost exclusively by the inward profit shifting of multinationals. Nevertheless, the welfare gain of 0.6 per cent is almost as large as the gain in the benchmark scenario, because the more generous initial depreciation allowances imply larger distortionary tax subsidies to debt-financed investment in the initial equilibrium.

The two bottom rows of Table 5 illustrate the sensitivity of the simulation results to the assumptions on the effectiveness of tax enforcement. The

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benchmark scenario assumes that 50 per cent of domestic source interest income and 25 per cent of foreign source interest and dividend income is subject to personal income tax. The second row from the bottom of Table 5 considers an alternative scenario with ineffective tax enforcement, where only 25 per cent of domestic source interest income and *none* of the foreign source portfolio income is subject to personal tax. In contrast, the bottom row of the table assumes that tax enforcement is fairly effective so that 75 per cent of domestic source interest income and 50 per cent of foreign portfolio income gets taxed. All scenarios assume that the authorities are able to tax all household dividend income from *domestic* sources, due to the monitoring of corporations done by external accountants and tax collectors, and due to the incentive under the old tax system to report dividend income to claim imputation tax credit.

With ineffective tax enforcement, the stimulus to private saving generated by the cuts in the marginal personal tax rate on capital income will be smaller, and hence the fall in the German interest rate will also be smaller. As a consequence, we observe a smaller increase in investment and output. At the same time the revenue loss from the fall in personal tax rates on capital income will also be smaller, so the welfare gain per unit of revenue lost will be quite high, as indicated in Table 5. If tax enforcement is rather effective, the personal tax cuts have a stronger positive impact on saving, investment and GDP. In this case the revenue loss is limited by the fairly large increase in economic activity, so again the welfare gain per unit of revenue lost will be high.

5. CONCLUSIONS

Let me sum up my main findings and offer some concluding remarks. The recent German business tax reform involves a cut in marginal tax rates, financed to a large extent by a broadening of the business income tax base. The analysis in this paper indicates that the reform will produce a non-negligible gain in economic efficiency. This conclusion seems fairly robust to changes in a number of uncertain parameters. The efficiency gain will come mainly from lower corporate and personal tax rates, whereas the much disputed dividend tax reform seems to be slightly welfare-reducing, because it partly reinstates the double taxation of dividends. However, the impact of the dividend tax reform on German stock prices will be limited by the international openness of the German stock market and by the fact that most equity finance comes from retained profits.

In the benchmark scenario, the OECDTAX model implies that the total business tax reform will generate a modest public revenue loss of about 0.24 per cent of GDP and an aggregate welfare gain which is almost three times as large, assuming that the revenue loss will be followed up by a cut in (lump-sum) transfers to German households of equal present value. The source of the welfare gain is a boost in after-tax property incomes, so the gain will accrue

disproportionately to households with a high ratio of property income to total income over the life cycle.

As a result of the German reform, other OECD countries will experience an outflow of capital and corporate tax bases to Germany. The welfare gain for Germany will therefore tend to come at the expense of the rest of the world, but according to simulations with the OECDTAX model, which are not recorded here, the negative spillover effects on other countries will be quite small (see Sørensen, 2001b).

The quantitative estimates presented above are of course rather uncertain, since we lack solid empirical estimates of many of the parameters in the OECDTAX model. The main purpose of this paper was not to offer particular numbers, but rather to present a methodology for quantitative tax reform analysis in an interdependent world economy. To illustrate the need for general equilibrium analysis, recall that the new half-income system of dividend taxation eliminates the previous tax discrimination against dividends paid out of foreign source corporate income. Hence one might think that the half-income system will stimulate outbound direct investment from Germany. But as we have seen, the switch to the half-income system also increases the tax burden on dividends from domestic sources, and the resulting drop in demand for German shares may well discourage outbound direct investment by raising the cost of equity capital for German multinationals. To determine the net effect on foreign direct investment, we must rely on a quantitative general equilibrium analysis. In this paper I have tried to show that it is possible to construct general equilibrium models which account for a lot of the complexities of real-world tax systems and which may therefore help to bring academic research closer to the concerns of policy-makers.

APPENDIX

In the first section of this appendix I briefly describe how the sector of multinational corporations is specified in the OECDTAX model. In the second section I explain how the German system of domestic and international double tax relief has been modeled. The third section lists the data sources used in the calibration of the model.

A.1. Multinational corporations

Multinational corporations consist of parent companies and foreign subsidiaries. The representative parent company headquartered in the domestic country j owns one subsidiary in each foreign country v . In the following, the superscript m always refers to the domestic parent company, while superscript F refers to a foreign subsidiary. The parent company produces output Y^m by means of labour L^m , capital K^m and a fixed intangible asset A^m , using the Cobb–Douglas technology:

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$$Y_j^m = (A_j^m)^{1-\alpha_j-\beta_j} (L_j^m)^{\alpha_j} (K_j^m)^{\beta_j} \quad 0 < \alpha_j + \beta_j < 1 \quad (\text{A.1})$$

The parent company may sell part of its output as an input Q_{vj} used in the production process of the foreign subsidiary in country v . The true cost of the input is equal to the producer price of output which is unity, but the parent may choose to charge a transfer price $p_{vj}^Q \neq 1$ to the subsidiary with the purpose of shifting taxable profits between the parent and the subsidiary. If the transfer price deviates from the true input price, the multinational incurs an organizational cost a_{vj}^Q per unit of Q_{vj} , arising from distorted pricing of intracompany transactions. For each unit of capital the firm also incurs a 'cost of financial distress' a_j^{dm} which is positive to the extent that the firm's actual debt ratio d_j^m deviates from some target ratio. If τ_j^m is the average statutory corporate tax rate, W_j is the wage rate, $\hat{\rho}_j^m$ is the required return on the firm's equity before investor-level tax, i_j is the pre-tax interest rate, α_j^d is the tax-deductible fraction of interest expenses, δ_j is the true rate of depreciation, and $\hat{\delta}_j$ is the rate of depreciation for tax purposes, the parent company's after-tax economic profits from *domestic* sources may be written as:

$$\begin{aligned} \Pi_j^m = & \left(1 - \tau_j^m\right) \left[Y_j^m - W_j L_j^m + \sum_{v=1, v \neq j}^n (p_{vj}^Q - 1 - a_{vj}^Q) Q_{vj} - a_j^{dm} K_j^m \right] \\ & - \left[\hat{\rho}_j^m (1 - d_j^m) + d_j^m i_j + \delta_j - \tau_j^m (\alpha_j^d d_j^m i_j + \hat{\delta}_j) \right] K_j^m \end{aligned} \quad (\text{A.2})$$

The organizational cost of distorted transfer prices is assumed to be:

$$a_{vj}^Q = \frac{(p_{vj}^Q - 1)^{1+\epsilon_j^Q}}{1 + \epsilon_j^Q} \quad \text{for } \tau_{vj}^F \geq \tau_j^m \quad \text{and} \quad a_{vj}^Q = \frac{(1 - p_{vj}^Q)^{1+\epsilon_j^Q}}{1 + \epsilon_j^Q} \quad \text{for } \tau_{vj}^F < \tau_j^m \quad (\text{A.3})$$

where τ_{vj}^F is the average statutory corporate tax rate for a subsidiary operating in foreign country v . The multinational will have an incentive to set $p_{vj}^Q > 1$ when $\tau_{vj}^F > \tau_j^m$ and to choose $p_{vj}^Q < 1$ when $\tau_{vj}^F < \tau_j^m$ in order to shift taxable profits from high-tax to low-tax jurisdictions. Thus the specifications in (A.3) ensure that the costs of deviating from the 'correct' transfer price will always be positive. Note that government regulation of transfer prices may raise the costs of deviating from the correct transfer price by raising the value of the parameter ϵ_j^Q .

As a parallel to (A.3), the parent's costs of financial distress per unit of capital are given by:

$$a_j^{dm} = \frac{(d_j^m - \bar{d}_j^m)^{1+\epsilon_j^d}}{1 + \epsilon_j^d} \quad \text{for } d_j^m \geq \bar{d}_j^m \quad \text{and} \quad a_j^{dm} = \frac{(\bar{d}_j^m - d_j^m)^{1+\epsilon_j^d}}{1 + \epsilon_j^d} \quad \text{for } d_j^m < \bar{d}_j^m \quad (\text{A.4})$$

where \bar{d}_j^m is the exogenous target debt ratio, and where the tax-privileged status of debt finance typically gives the firm an incentive to choose $d_j^m > \bar{d}_j^m$.

Consider next the foreign subsidiaries of the multinational. For a foreign subsidiary owned by a parent in country j and operating in country v , output Y_{vj}^F is given by the Cobb–Douglas technology:

$$Y_{vj}^F = (\bar{Q}_v)^{1-\varsigma_v-\alpha_v^F-\beta_v^F} (Q_{vj})^{\varsigma_v} (L_{vj}^F)^{\alpha_v^F} (K_{vj}^F)^{\beta_v^F}, \quad 0 < \varsigma_v + \alpha_v^F + \beta_v^F < 1 \quad (\text{A.5})$$

The exogenous variable \bar{Q}_v is a fixed public input indicating the extent to which the infrastructure of the host country v promotes the effective local utilization of the specific assets of foreign multinationals. Because it is a public input, the pure (after-tax) profits arising from the exploitation of this fixed factor accrue to the owners of the domestic parent company, forming part of total household income in the parent company's home country j .

If τ_{vj}^F is the multinational company's total average tax rate on profits generated by a foreign subsidiary in country v , the parent's after-tax economic profits from this subsidiary (Π_{vj}^F) are equal to:

$$\begin{aligned} \Pi_{vj}^F = & \left(1 - \tau_{vj}^F\right) \left(Y_{vj}^F - W_v L_{vj}^m - p_{vj}^Q Q_{vj} - a_{vj}^{dF} K_{vj}^F\right) \\ & - \left[\hat{\rho}_j^m \left(1 - d_{vj}^F\right) + d_{vj}^F i_v + \delta_v - \tau_{vj}^F \left(\alpha_v^d d_{vj}^F i_v + \hat{\delta}_v\right)\right] K_{vj}^F \end{aligned} \quad (\text{A.6})$$

Equation (A.6) assumes that the subsidiary is 100 per cent owned by the parent which thus provides the subsidiary with all of its equity at an opportunity cost equal to the cost of equity $\hat{\rho}_j^m$ in the parent's home country j . In addition, the subsidiary finances a fraction d_{vj}^F of its capital stock by issuing debt in the foreign host country v . Its cost of financial distress is:

$$a_{vj}^{dF} = \frac{(d_{vj}^F - \bar{d}_v^m)^{1+\epsilon_v^d}}{1 + \epsilon_v^d} \quad \text{for } d_{vj}^F \geq \bar{d}_v^m \quad \text{and} \quad a_{vj}^{dF} = \frac{(\bar{d}_v^m - d_{vj}^F)^{1+\epsilon_v^d}}{1 + \epsilon_v^d} \quad \text{for } d_{vj}^F < \bar{d}_v^m \quad (\text{A.7})$$

The total tax rate on distributed foreign source profits τ_{vj}^d may deviate from the total tax rate τ_{vj}^r on profits which are retained abroad. Assuming that an exogenous fraction \hat{g}_j^F of taxable foreign source profits is distributed to the parent company, we thus have:

$$\tau_{vj}^F = \hat{g}_j^F \tau_{vj}^d + \left(1 - \hat{g}_j^F\right) \tau_{vj}^r \quad (\text{A.8})$$

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where τ_{vj}^d and τ_{vj}^r include taxes paid by the parent as well as the subsidiary. As a parallel, if the parent distributes an exogenous fraction \hat{g}_j^m of its total taxable profits as dividends, its effective corporate tax rate will be:

$$\tau_j^m = \hat{g}_j^m \tau_j^d + (1 - \hat{g}_j^m) \tau_j^r \quad (\text{A.9})$$

The multinational chooses L_j^m , K_j^m , d_j^m , Q_{vj} , p_{vj}^Q , L_{vj}^F , K_{vj}^F and d_{vj}^F so as to maximize its global after-tax economic profits:

$$\Pi_j^{gm} = \Pi_j^m + \sum_{v=1, v \neq j}^n \Pi_{vj}^F \quad (\text{A.10})$$

subject to the constraints given by (A.1) through (A.9). The resulting behavioral equations are derived in Sørensen (2001a).

A.2. Domestic and international double tax relief

This section briefly describes how the German system of international and domestic double tax relief has been modeled.

Distributed profits in German-owned foreign subsidiaries are subject to the source country corporate tax rate τ_v^d . In addition, profits repatriated from countries outside the EU may be subject to a source country withholding tax rate τ_{vj}^{wF} . When the income originates from a tax treaty partner country, 95 per cent of the dividend received by the German parent company is exempted from German corporation tax, whereas the remaining 5 per cent is subject to the German corporate tax rate τ_j^m . Hence the total corporate-level tax on repatriated foreign profits from source country v becomes:

$$\tau_{vj}^d = \tau_v^d + \tau_{vj}^{wF} (1 - \tau_v^d) + \tau_j^m \cdot 0.05 (1 - \tau_{vj}^{wF}) (1 - \tau_v^d) \quad (\text{A.11})$$

Since capital gains on shares in foreign subsidiaries operating in tax treaty partner countries are exempted from German corporation tax, the corporate tax rate τ_{vj}^r on profits which are retained abroad is simply equal to the host country corporate tax rate τ_v^r .

Consider next the alleviation of domestic double taxation at the household investor level. Under the previous German imputation system shareholders were granted a credit against their personal tax for the corporate tax on the profits underlying their dividends. The so-called imputation rate \hat{u}_j reflected the amount of tax which was credited to the shareholder. If a household investor with a personal tax rate on dividends equal to m_j^{dh} received one unit of dividend net of corporation and withholding tax, his dividend income was 'grossed-up' by the amount $1/(1 - \hat{u}_j)$ and subjected to an amount of dividend tax $m_j^{dh}/(1 - \hat{u}_j)$. To arrive at the shareholder's net tax liability, the dividend tax bill was then reduced by an imputation credit (dividend tax credit) $\hat{u}_j/(1 - \hat{u}_j)$

intended to compensate for the corporation and withholding tax already paid. Hence the net personal tax rate on the net dividend paid out by the corporation was $(m_j^{dh} - \hat{u}_j)/(1 - \hat{u}_j)$, provided dividends were paid out of German source income. Dividends paid out of foreign source income did not qualify for imputation credits because such income had not borne German corporation tax (but the German dividend withholding tax was and still is creditable against the personal income tax). Let α_j^{ml} denote the proportion of dividends from German multinationals which did *not* attract imputation credits; let m_j^{ch} be the effective marginal personal tax rate on accrued capital gains on shares, and let p_j^d indicate the fraction of the total return on shares which takes the form of dividends. With this notation we may specify the effective tax rate z_j^{hm} on income from shares in German multinationals as:

$$z_j^{hm} = p_j^d \left[\alpha_j^{ml} m_j^{dh} + (1 - \alpha_j^{ml}) \left(\frac{m_j^{dh} - \hat{u}_j}{1 - \hat{u}_j} \right) \right] + (1 - p_j^d) (1 - m_j^{ch}) \quad (\text{A.12})$$

For holders of shares in German corporations without any international operations, the effective tax rate z_j^h is obtained by simply setting $\alpha_j^{ml} = 0$ in equation (A.12).

The tax code contained ordering rules specifying when the dividends paid by the parent of a German multinational company were considered to originate from foreign sources. In the OECDTAX model it is assumed that, on average, the proportion α_j^{ml} of dividends which did not attract dividend tax credit was equal to the amount of repatriated foreign source income relative to the total amount of profits which was potentially available for distribution to the parent company's shareholders.

Under the new half-income system of dividend taxation, the parameters α_j^{ml} and \hat{u}_j are zero, and the dividend tax rate m_j^{dh} is equal to half the marginal personal income tax rate. Moreover, for shareholders without a controlling interest, the capital gains tax rate m_j^{ch} is zero both before and after the reform.

A.3. Data sources

The national income statistics used in the calibration of the model were taken from the OECD National Accounts 1999 and 2000 and from the OECD Economic Outlook 62 and 66. Data on FDI came from the OECD Statistics Yearbook 2000, while estimates of structural unemployment rates were taken from the OECD database, FPBC 1999. Tax revenue data were found in the OECD Member State Revenue Statistics 2000, and estimates of the wealth held in pension funds were obtained from the European Commission (ECFIN/223/2001-EN). Most of the data on tax rules were taken from the OECD tax database 2000. Information on residential property taxes and capital gains tax rules was found in OECD (1991, 1994). The former source also provided data on regimes for international double tax relief, supplemented by updated information

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provided by Michael Devereux of Warwick University. Value-added tax rates were found in Ebrill *et al.* (2000), and estimates of effective tax rates on labor income and consumption were borrowed from Volkerink and de Haan (2000). Data on bank deposits held in tax haven jurisdictions came from Huizinga and Nicodème (2001).

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