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## Forecasting the Interindustry Development of the German Economy: The Model I FORGE

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# **Forecasting the Interindustry Development of the German Economy: The Model INFORGE**

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# **Forecasting the Interindustry Development of the German Economy: The Model INFORGE**

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## **Abstract**

INFORGE is a German interindustry forecasting model, that is based on the INFORUM philosophy. It has been used in a wide range of applications in the last years and is updated annually. The structure of the model is explained in detail. It contains an input-output module, an SNA and financial module and depicts the labour market in great detail. As almost all variables are endogenous to the model, only a few policy variables have to be set exogenously. Probable assumptions for the next years are discussed, that form a base scenario. Results of the base simulation until 2015 show, that Germany will reach again historical annual growth rates of GDP of about 2% after overcoming the current crisis. Trade will grow much faster throughout the simulation period. Public consumption is restricted due to the European stability pact. Construction will not recover, as population forecasts show a decline after 2010. Problems on the labour market diminish in the long run because of demographic change. Employment in manufacturing, agriculture and mining will decline in favour of services. But simulation results show that this shift is not caused by changes in the structure of production but due to higher productivity growth in manufacturing. In contrast to other countries, German manufacturers will keep their share in production.

Keywords: multi-sector models; economic forecasting

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## 1 INTRODUCTION

INFORGE is a simulation and forecasting model for the German economy, that describes the German economy for 59 industries. It has been updated annually since 1996 and used in various applications. It represents the economy in sector detail. The version described in the paper at hand has been used for labour market forecasts for the German Federal Employment Services. In chapter 2 the structure of INFORGE is illustrated in great detail. In chapter 3 a base forecast until 2015 is discussed. Simulation results for the macroeconomic and sector development are shown.

## 2 INFORGE – MODEL DESCRIPTION

### 2.1 SURVEY

The INFORGE (INterindustry FORecasting Germany) model is a forecasting and simulation model deeply structured by sectors which has been updated annually since 1996 and has been utilized in a wide range of applications (e. g. Elixmann/Keuter/Meyer 1997; Distelkamp et al. 2000; Ahlert 2001, Lutz et al. 2002, Wolter 2002, Distelkamp et al. 2003, Meyer 2003). The version at hand is based on the „Statistical Classification of Economic Activities in the European Community“ (NACE) of National Accounts. According to the classification of West (1995) it is an “econometric + input-output model”, that belongs to the family of national interindustry models of the INFORUM family.

The particular efficiency of the INFORGE model relies on the INFORUM philosophy (Almon 1991). Its significant factors are the construction principles of bottom-up and complete integration. The bottom-up construction principle says that each of the 59 sectors of the national economy bears a detailed structure and that the macroeconomic variables are formed by explicit aggregation in the context of the model. The construction principle of *complete integration* includes a complex and simultaneous modelling describing interindustry interlinking as well as the generation and distribution of income, government redistribution and the use of disposable income by private households for various commodities and services. The disaggregated structure of the INFORGE model is integrated into the fully endogenised System of National Accounts, thus providing especially an endogenous compilation of secondary distribution of income.

The model shows a very high level of endogenisation and is highly interdependent. Basically, tax rates, labour supply and the global market variables of the international INFORUM system (Nyhus 1991) are determined exogenously. It has to be stressed that the whole system is solved simultaneously. Apart from the regular interdependencies of the economic cycle, it monitors the volume-price interdependencies as well as the wage-price interdependencies.

INFORGE is an econometric input-output model, appropriately described as evolutionary. By means of behavioural equations, routines in decision-making processes

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are simulated which are not derived explicitly from optimisation activities performed by rational agents, but are based on bounded rationality on imperfect markets. Market prices result from mark-up calculation performed by companies. Time within this model is historic and irreversible. The adjustment of the capital stocks generates path dependency.

Usually, the input-output approach is considered to be a demand-oriented approach. This, however, does not account for INFORGE. While it is correct to say that within INFORGE demand determines production, it needs to be emphasized that all variables concerning demand for commodities and factors depend on, among other things, relative prices with prices, in turn, being set with regard to the unit costs of companies by means of a price-setting hypothesis. The differences between INFORGE and the Computable General Equilibrium (CGE) models in which a competitive market is simulated, concerning this aspect, lies in the presumed market form, not in the emphasis on one side of the market or the other (West 1995, 216). It might as well be said this way: Companies, on the basis of their cost situation and the prices of competitive imported goods, set their sales prices. Potential customers react to that with their decision which in turn determines the rate of production. Therefore, elements of both supply and demand are equally present.

Apart from the context of the input-output calculation deeply structured into 59 manufacturing industries. The model includes the System of National Accounts with its institutional sectors – government, private households and non-profit institutions serving households (NPISHs), financial corporations, non-financial corporations and the rest of the world – as well as the functional accounts of production, generation of income, allocation of primary income, secondary distribution of income, use of disposable income, and capital in order to calculate the SNA of the Federal Republic of Germany. This system comprises the complete redistribution of income including social insurance and taxation between government, private households and corporations, thus allowing the calculation of disposable income which is once more a significant determinant of final demand. Moreover, the financing account balances are ascertained. Therefore, the model includes especially government budget constraints. As a result, the entire fiscal policy is endogenously integrated into this system.

The parameters of the model equations have been econometrically estimated over the period from 1991 through 2000 using the OLS method. In choosing alternative approaches of estimation, first of all a priori information about sign and the order of magnitude of the coefficients to be estimated were utilized. In other words: Results of estimations that were economically nonsensical were dismissed. The remaining estimations were tested both for autocorrelation of residues according to the Durbin-Watson statistics, and for the significance of the estimated parameters by means of the t-test. When, on that basis, a discrimination of competing approaches was not possible, the coefficient of determination of the estimation was referred to. With regard to the enormous volume of the model, the OLS method appears to be the appropriate, that is, the easiest estimation method.

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## 2.2 FINAL DEMAND

### *Consumption of Private Households*

The macroeconomic private consumption demand  $CPVR$  is explained with regard to the disposable income of households in constant prices  $YVANH/PCPV$  and the interest rate  $RKONT$  for consumer credits. In the equation,  $PCPV$  stands for the index of consumer prices:

$$(1) \quad CPVR[t] = f\{YVANH[t] / PCPV[t], RKONT[t]\}$$

The shares of the 43 utilization purposes  $cpvrq_k$  of the consumption  $CPVR$  are explained with regard to the respective relative price, consisting of the price index of the utilization purpose  $pcpv_k$  and the index of consumer prices  $PCPV$ , the 10 year treasury bond rate  $RUML$  and the time trend  $ZEIT$ . Subsequently, the shares are scaled to 100 %.

$$(2) \quad cpvrq_k[t] = f\{pcpv_k[t]/PCPV[t], RUML[t], ZEIT[t]\}$$

The expenditures in constant prices for the purposes of utilization  $cpvr$  result from the multiplication of the rates by the aggregate consumption of private households:

$$(3) \quad cpvrk[t] = cpvrq_k[t] * CPVR[t]$$

Equally by definition, the expenditures of the purposes of utilization in current prices are ascertained:

$$(4) \quad cpvn_k[t] = cpvrk[t] * pcpv_k[t]$$

The consumption demand for commodity groups in current prices is calculated by means of the  $CPX$  bridge matrix of the year 2000, which within the lines contains the shares of a commodity group  $i$  of the different consumption purposes  $k$ :

$$(5) \quad cpn_i[t] = \sum_k (CPX_{i,k}[t=2000] * cpvn_k[t])$$

The trade and transport services included  $htcpn_i$ , the value-added taxes  $mwtcpn_i$ , the other taxes on products  $sgutcpn_i$  and the subsidies  $subcpn_i$  are ascertained using fixed rates which, however, are variable in model simulations.

$$(6) \quad htcpn_i[t] = qhtcp_i[2000] * cpn_i[t]$$

$$(7) \quad sgutcpn_i[t] = qsgutcp_i[2000] * cpn_i[t]$$

$$(8) \quad mwtcpn_i[t] = qmwtcp_i[2000] * cpn_i[t]$$

$$(9) \quad subcpn_i[t] = qsubcp_i[2000] * cpn_i[t]$$

By subtracting the trade and transport services as well as the other transitional factors from the consumption expenditures at market prices  $cpn$ , we get the consumption expenditures at basic prices  $cpun$ :

$$(10) \quad cpun_i[t] = cpn_i[t] - htcp_i[t] - sgutcpn_i[t] - mwtcpn_i[t] + subcpn_i[t]$$

The basic prices of consumer products  $pcpu$  depend on the unit costs  $uc$  of the sector and the prices  $pim$  of the competing imported goods:

$$(11) \quad pcpu_i[t] = f\{uc_i[t], pim_i[t]\}$$

The market prices of consumer products  $pcp$  are explained with regard to the basic prices  $pcpu$  and the rate of the respective taxes on products levied on them:

$$(12) \quad pcp_i[t] = f\{(1+qmwtp_i[t])*pcpu_i[t], (1+qmwtp_i[t]) * (sgutcpn_i[t] - subcpn_i[t])/cpr_i[t]\}$$

The prices of the 43 utilization purposes  $pcpv_k$  are ascertained with regard to the market prices  $pcp_i$  of the consumer products included in them:

$$(13) \quad pcpv_k[t] = f\{pcp_1[t], pcp_2[t], ..., pcp_n[t]\}$$

The division of the nominal factors  $cpn$  or  $cpun$  respectively by the appertaining prices  $pcp$  or  $pcpu$  respectively leads to the actual factors  $cpr$  or  $cpur$  respectively in either price concept.

$$(14) \quad cpr_i[t] = 100 * cpn_i[t]/pcp_i[t]$$

$$(15) \quad cpur_i[t] = 100 * cpun_i[t]/pcpu_i[t]$$

The appertaining macroeconomic factors can be calculated by addition, the price indices by division of the nominal by the real factors with the price basis being 1995. The sum of trade and transport services paid over all commodities is zero.

The ascertaining of sums will not be explained any further in the course of this paper. Within the model, however, the macroeconomic variables for all sector variables are ascertained by aggregation.

#### *Consumption Expenditures of Non-Profit Institutions Serving Households (NPISHs)*

The consumption expenditures  $cpour$  in constant prices of NPISHs are determined by, among other things, the development of the actual gross domestic product (GDP)  $BIPR$  or the government consumption expenditures in the area of social security contributions  $CSLR$ :

$$(16) \quad cpour_i[t] = f\{BIPR[t], CSLR[t]\}$$

The market prices of consumer products of NPISHs  $pcpo$  are identical to the basic prices  $pcpou$ , which depend on the unit costs of the respective sector:

$$(17) \quad pcpou_i[t] = f\{uc_i[t]\}$$

The corresponding factors in current prices are the result of multiplication by the corresponding basic prices  $pcpou$ :

$$(18) \quad cpoun_i[t] = cpour_i[t] * pcpou_i[t]$$

The macroeconomic parameters result from aggregation and division as explained above.

### *Consumption Expenditures of General Government*

The consumption expenditures of general government is subdivided into for social security benefits and government consumption. Due to, among other things, the current political discussion, the simulation of overall government expenditures for social security benefits in current prices *CSLN* requires differentiation: Assuming that the demand among people from the age of 65 years upward (*ELDER*) for health benefits is about twice as high as among younger people (*CHILDREN*, *WORKING*), a level of cost per capita *CSLKN* can be calculated. Assuming that expenditures per capita in public health depend particularly on medical technological progress, the level of cost per capita is projected with a time trend (*ZEIT*).

$$(19) \quad CSLKN[t] = f\{ZEIT\}$$

*CSLN* then results from the multiplication of the segments of the population by the level of cost:

$$(20) \quad CSLN[t] = CSLKN[t] * (CHILDREN[t] + WORKING[t] + 2 * ELDER[t])$$

The social security benefits structured by commodity groups *csln* are ascertained by the relative price *pcsl* in proportion to the aggregated price *PCSL* and the aggregated expenditures *CSLN*:

$$(21) \quad csln_i[t] = f\{pcsl_i[t]/PCSL[t], CSLN[t]\}$$

The trade and transport services as well as the value-added taxes included are recorded via constant rates *qhtcs* or *qmwtc*s respectively:

$$(22) \quad htcsn_i[t] = qhtcs_i[t=2000] * csln_i[t]$$

$$(23) \quad mwtcn_i[t] = qmwtc_i[t=2000] * csln_i[t]$$

When the trade and transport services as well as the value-added taxes are subtracted from the social security contributions at market prices *csln*, the result is the social security contributions at basic prices *cslun*:

$$(24) \quad cslun_i[t] = csln_i[t] - htcs_i[t] - mwtcn_i[t]$$

The division of the variables at current prices *csln* or *cslun* respectively by the corresponding price indices *pcsl* or *pcslu* respectively leads to the real variables *cslr* or *cslur* respectively in both price concepts.

$$(25) \quad cslr_i[t] = 100 * csln_i[t]/pcsl_i[t]$$

$$(26) \quad cslur_i[t] = 100 * cslun_i[t]/pcslu_i[t]$$



The prices  $pcsl$  and  $pcslu$  are projected with the growth rate of the price index of the consumption demand for the respective commodity group  $pcg$ , since an econometric explanation was not possible. The development of the price of health goods (commodity group 54) is exogenous to the model as it is dependent on policy decisions.

Government consumption in current prices as a whole  $CSVN$  is dependent on the development of the gross domestic product. The proportion of both factors  $STVQ$  is interpreted as the government consumption rate the development of which is predetermined. Thus it is presumed that the government consumption is a deliberate decision made by the government, according to government functions.

$$(27) \quad CSVN[t] = STVQ[t] * BIPN[t-1]$$

The nominal government consumption structured by composite commodities  $csvn$  is explained with regard to the overall government expenditures:

$$(28) \quad csvn_i[t] = f\{CSVN[t]\}$$

The market prices of the government consumption  $pcsv$  are identical to the basic prices  $pcsvu$ , which in turn depend on the price index of the respective commodity group or the macroeconomic price index of the gross domestic product.

$$(29) \quad pcsvu_i[t] = f\{pg_i[t], PBIP[t]\}$$

The actual government consumption in prices of 1995 result from definition:

$$(30) \quad csvr_i[t] = 100 * csvn_i[t] / pcsvu_i[t]$$

The overall government consumption demand ( $csn$ ,  $csr$ ) is ascertained by the addition of the consumption demand for social security contributions ( $csln$ ,  $cslr$ ) and government consumption ( $csvn$ ,  $csvr$ ).

### *Equipment Investment*

The starting point of the simulation of investments is the investing industries. The equipment expenditures of a industry  $j$   $iasr$  depend on its gross production  $xsr$ , its capital stock  $kasr$  as well as the actual interest – treasury rate  $RUML$  minus inflation rate  $INFL$  – and further sector-specific variables. In order to record the expectations concerning the macroeconomic development, the CDAX share index in each sectoral function of investments is tested with a one-year advance ( $CDAXL$ ). In case of obvious significance it is integrated into the function.

$$(31) \quad iasr_j[t] = f\{xsr_j[t], kasr_j[t], (RUML[t] - INFL[t]), CDAXL, \dots\}$$

The replacement from the capital stock of the industry  $j$   $aasr$  depends on the development of the capital stock with allocated lags:

$$(32) \quad aasr_j[t] = f\{aasr_j[t-1], kasr_j[t-1]\}$$

The development of the capital stock for equipment results from definition:

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$$(33) \quad kasr_j[t] = kasr_j[t-1] + iasr_j[t] - aasr_j[t]$$

The vector of the equipment expenditures structured by commodity groups at market prices in constant prices before the deduction of the purchases/sales of equipment and other assets  $iarh$  results from the multiplication of the  $IAX$  bridge matrix of the year 2000 by the vector of the equipment expenditures structured by industries. Within the lines the matrix includes the shares of the investments of the 59 industries which are made following the demand for equipment expenditures of the commodity group  $i$ .

$$(34) \quad iarh_i[t] = \sum_j (IAX_{ij}[2000] * iasr_j[t])$$

The purchases/sales of equipment and other assets in constant prices ( $invar$ ) are ascertained by means of constant rates ( $qinvar$ ) of the year 2000 of equipment expenditures in constant prices before the deduction of the purchases/sales of equipment and other assets.

$$(35) \quad invar_i[t] = qinvar_i[2000] * iarh_i[t]$$

The equipment expenditures with reference to commodity groups at market prices in constant prices ( $iar$ ) result from definition:

$$(36) \quad iar_i[t] = iarh_i[t] - invar_i[t]$$

Multiplication by the market prices  $pia$  results in the nominal equipment at market prices:

$$(37) \quad ian_i[t] = 0.01 * iar_i[t] * pia_i[t]$$

The trade and transport services  $htian$  included as well as the value-added taxes  $mwtian$  and the taxes on products  $sgutian$  are ascertained via constant rates:

$$(38) \quad htian_i[t] = qhtia_i[2000] * ian_i[t]$$

$$(39) \quad mwtian_i[t] = qmwtia_i[2000] * ian_i[t]$$

$$(40) \quad sgutian_{51}[t] = qsgutia_{51}[2000] * ian_{51}[t]$$

By the subtraction of the trade and transport services as well as the value-added taxes from the equipment at market prices  $ian$ , you get as the result the equipment at basic prices  $iaun$ . For line 51 (business-related services), additionally the taxes on products have to be taken into consideration.

$$(41) \quad iaun_i[t] = ian_i[t] - htian_i[t] - mwtian_i[t]$$

The division of the parameters in current prices  $iaun$  by the appertaining prices  $piau$  leads to the factors in constant prices  $iaur$  within the concept of the basic prices:

$$(42) \quad iaur_i[t] = 100 * iaun_i[t] / piau_i[t]$$

The basic prices of equipment  $piau$  depend on the appertaining unit costs  $uc$  and the prices of competing imported goods  $pim$ :

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$$(43) \quad pia_{ui}[t] = f\{uc_i[t], pim_i[t]\}$$

The market prices of equipment  $pia$  again are determined by the respective basic prices and the rates of the taxes on products.

$$(44) \quad pia_i[t] = f\{(1+qmwta_i[2000]) * pia_{ui}[t]\}$$

The prices of equipment expenditures with reference to investing industries  $pias$  are determined by the prices of the composite commodities  $n$  included in them.

$$(45) \quad pias_i[t] = f\{pia_1[t], pia_2[t], \dots, pia_n[t]\}$$

### *Construction Expenditures*

The simulation of construction expenditures  $isbr$  has been selected in analogy with the one concerning equipment. For the construction expenditures of industries the following approaches are estimated:

$$(46) \quad ibsr_j[t] = f\{xsr_j[t], kbsr_j[t], (RUML[t] - INFL[t]), \dots\}$$

The function of construction expenditures of sector 47 (services of the real estate and housing sector) is subject to particular specification. For this sector, an estimation is dispensed with, presuming a development simulating a retrogression to the level of 1991. This simulation is based on the observation that an estimated function is by no means able to project the development of the years 2001 and 2002. Additionally, historical observation shows that, on the one hand, there has been economic cycles concerning construction, that on the other hand, however, a long-term rise in construction investment in constant prices is not in sight and that the development over the past years is exclusively due to German reunification or has been completely covered over by it.

### *Export Demand*

The export demand in constant prices of a commodity group  $exr_i$  is explained with regard to the respective German export  $iexr_m$  of the international INFORUM system.

$$(47) \quad exr_i[t] = f\{iexr_m[t]\}$$

Multiplication by the market prices  $pex$  produces the result of the export at current market prices:

$$(48) \quad exn_i[t] = 0.01 * exr_i[t] * pex_i[t]$$

The trade and transport services included as well as the government subsidies are recorded by means of constant rates:

$$(49) \quad htexn_i[t] = qhtex_i[t=2000] * exn_i[t]$$

$$(50) \quad subexn_i[t] = qsubex_i[t=2000] * exn_i[t]$$

By subtracting the trade and transport services as well as the subsidies from the export at market prices  $exn$ , you get the export at basic prices  $exun$ :

$$(51) \quad exun_i[t] = exn_i[t] - htexn_i[t] + subexn_i[t]$$

The division of the factors in current prices  $exun$  by the appertaining basic price  $pexu$  produces the result of the export in constant prices  $exur$ .

$$(52) \quad exur_i[t] = 100 * exun_i[t] / pexu_i[t]$$

The export prices according to the basic price concept  $pexu$  of the commodity group  $i$  are explained with regard to the unit costs of the sector  $uc$  and the appertaining import price  $pim$ .

$$(53) \quad pexu_i[t] = f\{pim_i[t], uc_i[t]\}$$

The export prices of the market price concept  $pex$  result from the export prices according to the basic price concept  $pexu$ . In the process, agriculture (commodity group 1) is the only sector for which government subsidies have to be taken into consideration.

$$(54) \quad pex_i[t] = f\{pexu_i[t]\}$$

$$(55) \quad pex_1[t] = f\{pexu_1[t], subexn_1[t] / exr_1[t]\}$$

### *Aggregated Final Demand*

Up to this point, the simulation of the single component parts of final demand has been explained. Only the inventory stocks  $ivur$  or  $ivun$  respectively remain exogenous. For them, an exogenous development is presumed which, over a long-term period, will reduce them to zero. The combination of these aspects then results in the final demand at basic prices:

$$(56) \quad fgur[t] = cpur[t] + cpour[t] + cslur[t] + csvr[t] + iaur[t] \\ + ibur[t] + ivur[t] + exur[t]$$

$$(57) \quad fgun[t] = cpun[t] + cpoun[t] + cslun[t] + csvn[t] + iaun[t] \\ + ibun[t] + ivun[t] + exun[t]$$

$$(58) \quad pfgu[t] = 100 * fgun[t] / fgur[t]$$

The final demand at market prices  $fgr$  or  $fgn$  respectively as well as the component parts of the net commodity taxes ( $mwtfgn$ ,  $sgutfgn$ ,  $subfgn$ ) can be calculated accordingly. Eventually, the macroeconomic factors are determined by aggregation.

## **2.3 INTERMEDIATE DEMAND**

The  $XR$  matrix describes the interlinking of intermediate inputs in constant basic prices of the year 1995, the  $YN$  matrix represents the interlinking of intermediate inputs in current

basic prices. The input coefficient  $AR_{ij}$  is defined as the quotient of the intermediate inputs of the commodity  $i$  in the sector  $j$  and the gross production of the sector  $j$ . The input coefficients are variable and are explained by a relative price from the price index of the intermediate inputs  $pvg_i$  of the delivering sector and the price of the gross production  $pg_j$  of the receiving sector as well as a time trend  $ZEIT$ . The variability of the input coefficients is not considered the result of factor substitution, but the effect of cost-push induced technological progress which leads to improvements of limitational processes. The presumption of substitutional technologies does not make a lot of sense concerning the intermediate demand, since intermediate inputs are part of the product and, therefore, an alteration of the intermediate inputs redefines the product (Georgescu Roegen 1990).

$$(59) \quad AR_{ij}[t] = f\{pvg_i[t]/pg_j[t], ZEIT[t]\}$$

The deliveries of intermediate inputs of the commodity group at constant basic prices then result from:

$$(60) \quad vgr_i[t] = \sum_j (AR_{ij}[t] * xgr_j[t])$$

The appertaining price index  $pvg_u$  is explained with regard to the unit costs  $uc$  of the domestic production of the commodity group and the corresponding import price, since import is included within deliveries of intermediate inputs as well. Subsequently, the intermediate inputs in current prices can be ascertained:

$$(61) \quad pvg_u[t] = f\{uc_i[t], pim_i[t]\}$$

$$(62) \quad vgu_i[t] = 0.01 * vgr_i[t] * pvg_u[t]$$

## 2.4 DOMESTIC PRODUCTION AND IMPORT

The gross production is defined as the sum of demand for intermediate and final demand minus the import  $imr$ :

$$(63) \quad xgr_i[t] = vgr_i[t] + fgur_i[t] - imr_i[t]$$

The substitution of the demand for intermediate inputs by the equation 60 and the solving of the equation towards the vector of gross production results in the vector terms:

$$(64) \quad xgr[t] = (E - AR[t])^{-1} * (fgur[t] - imr[t])$$

In the process,  $E$  is the unit matrix. The demand for import  $imr$  is ascertained with regard to the gross production of the commodity group and the proportion of the domestic price of the commodity group to the import price:

$$(65) \quad imr_i[t] = f\{xgr_i[t], pg_i[t]/pim_i[t]\}$$

The import prices  $pim$  are explained with regard to the corresponding import prices of Germany within the international INFORUM system. The import in current prices  $imn$  then can be ascertained by definition:

$$(66) \quad pim_i[t] = f\{pim_m[t]\}$$

---


$$(67) \quad imn_i[t] = 0.01 * imr_i[t] * pim_i[t]$$

The gross production  $ygn$  is defined as the sum of the intermediate demand  $vgn$  and the final demand  $fgun$  at current prices minus the import in current prices  $imn$ :

$$(68) \quad ygn_i[t] = vgun_i[t] + fgun_i[t] - imn_i[t]$$

The price index of the gross production  $pg$  then is determined by definition as:

$$(69) \quad pg_i[t] = 100 * ygn_i[t] / xgr_i[t]$$

## 2.5 GROSS VALUE ADDED OF PRODUCTION SECTORS

The level of intermediate inputs of the sector  $j$  in constant basic prices can be ascertained by definition by the aggregation of the various single inputs of commodities utilized in the sector  $j$ :

$$(70) \quad vegur_j[t] = \sum_i (AR_{ij}[t] * xgr_j[t])$$

The nominal intermediate inputs at basic prices of the sector  $j$  are the result of the multiplication of the intermediate inputs in real terms by the appertaining manufacturing price  $pvgu$  and their subsequent aggregation:

$$(71) \quad \begin{aligned} vegun_j[t] &= \sum_i (XR_{ij}[t] * pvgu_i[t]) \\ &= \sum_i (AR_{ij}[t] * xgr_j[t] * pvgu_i[t] * 0.01) \end{aligned}$$

Subsequently, the net commodity taxes levied on the inputs of intermediate inputs sector  $j$  has to pay have to be ascertained. For this purpose, the corresponding tax or government subsidy vectors are transferred from composite commodities to sectors of production by means of subdivision matrices –  $STX$  for the value-added taxes and the other commodity taxes,  $SUBX$  for government commodity subsidies. By means of this, an appropriate assignment of the net commodity taxes to the sectors of production is achieved.

$$(72) \quad \begin{aligned} ngutven_j[t] &= \sum_i (STX_{ij}[2000] * (sgutvgn_i[t] + mwtvgn_i[t]) \\ &\quad - SUBX_{ij}[2000] * subvgn_i[t]) \end{aligned}$$

The tax loads in constant prices are calculated by means of deflating by the price vector of intermediate inputs  $pvegu$ .

$$(73) \quad ngutver_j[t] = 100 * ngutven_j[t] / pvegu_j[t]$$

The gross value added of a sector of production  $j$  in constant ( $bwgr$ ) or current prices ( $bwgn$ ) results from definition. The price indices of the gross value added  $pbwg$  and the levels of intermediate inputs  $pvegu$  then as well can be calculated:

$$(74) \quad bwgn_j[t] = ygn_j[t] - vegun_j[t] - ngutven_j[t]$$

$$(75) \quad bwgr_j[t] = xgr_j[t] - vegur_j[t] - ngutver_j[t]$$

$$(76) \quad pbwg_j[t] = 100 * bwgn_j[t] / bwgr_j[t]$$

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$$(77) \quad pvegu_j[t] = 100 * vegun_j[t]/vegur_j[t]$$

Eventually, the generation of the gross domestic product in current (*BIPN*) and constant (*BIPR*) prices can be calculated by means of the sum of the gross value added of all sectors of production. In the process, the commodity taxes *NGUTVEN* or *NGUTVER* respectively levied on the final demand *NGUTFGN* or *NGUTFGR* respectively and the intermediate demand get integrated into the gross domestic product. An alternative way of calculating the gross domestic product within the context of the simulation refers to the demand side being the sum of domestic demand and external balance surplus. The price deflator of the gross domestic product results from definition:

$$(78) \quad BIPR[t] = BWGR[t] + NGUTFGR[t] + NGUTVER[t]$$

$$(79) \quad BIPN[t] = BWGN[t] + NGUTFGN[t] + NGUTVEN[t]$$

$$(80) \quad PBIP[t] = 100 * BIPN[t]/BIPR[t]$$

## 2.6 GROSS VALUE ADDED OF THE INDUSTRIES AND ITS COMPONENTS

The transition from sectors of production discussed up to this point to the industries is performed by means of a *MAKE* matrix which within the lines contains the shares of a industry *j* of the production of the commodity group *i*. As a consequence, the equations below account for the gross value added in current prices *bwsn* of the industry *j* or its gross value added in constant prices *bwsr* and the corresponding price index:

$$(81) \quad bwsn_j[t] = \sum_i MAKE_{ij}[t=2000] * bwgn_i[t]$$

$$(82) \quad bwsr_j[t] = \sum_i MAKE_{ij}[t=2000] * bwgr_i[t]$$

$$(83) \quad pbws_j[t] = 100 * bwsn_j[t]/bwsr_j[t]$$

In an analogue way, the nominal or real gross production *ysn* or *xsr* respectively as well as the appertaining prices *ps* are ascertained.

The other production charges minus the government subsidies *npsn* are estimated as functions of the gross production:

$$(84) \quad npsn_j[t] = f\{ygn_j[t]\}$$

The gross wages and salaries *lsn* are ascertained by definition as being the product of the labour costs per employee *jas* and the number of employees *bas*. The endogenisation of the total annual wages and the employees will be discussed below within the context of other variables of the labour market.

$$(85) \quad lsn_j[t] = 0,000001 * jas_j[t] * bas_j[t]$$

The consumption of fixed capital *dsm* is estimated with regard to the sum of the capital stock of equipment and construction in current prices. In the process, the capital stocks in

constant prices  $kasr$  and  $kbsr$  are evaluated along with the current investments  $PIA$  and  $PIB$ , that is, at cost prices:

$$(86) \quad ds_n_j[t] = f\{kasr_j[t] * PIA[t] + kbsr_j[t] * PIB[t]\}$$

The gross operating surplus  $gsn$  of the sector  $j$  results from definition as being the remainder:

$$(87) \quad gsn_j[t] = bwsn_j[t] - nspn_j[t] - lsn_j[t] - ds_n_j[t]$$

The unit costs  $uc$  of the industry  $j$  are defined as:

$$(88) \quad uc_j[t] = (ys_n_j[t] - gsn_j[t])/xsr_j[t]$$

## 2.7 LABOUR MARKET

First of all, the macroeconomic average wage rate per hour  $SLS$  is calculated. For this purpose, a wage function is modelled which explains in a Phillips curve approach the result of the collective bargaining negotiations. Its determinants are macroeconomic productivity, resulting from the proportion of the GDP in constant prices  $BIPR$  to the total number of employees  $BAS$ , price development – described by the consumer price index  $PLH$  – and the labour market situation, represented by the unemployment rate  $ELQ$ . The following dynamic formula proved to be superior to other approaches:

$$(89) \quad SLS[t] = f\{BIPR[t-1]/BAS[t-1], PLH[t-1], ELQ[t-1]\}$$

In combination with the exogenously determined average annual working time of an employee  $JAB$ , the average total annual wage  $JLS$  can be calculated:

$$(90) \quad JLS[t] = SLS[t] * JAB[t]$$

Along with sector-specific variables,  $JLS$  then explains the sum of the gross wages and salaries per employee of the industries  $jls$ :

$$(91) \quad jls_j[t] = f\{JLS[t], \dots\}$$

As a consecutive step, the social security contribution rates of the employers  $sozagsq$  are ascertained. For this purpose, in each simulation year the macroeconomic rate of contribution  $SOZAGSQ$  in the respective first iteration is ascertained. It results from the proportion of the financial payments of the social insurances ( $GSNGNS$ ) – retirement payments and unemployment benefits – plus the expenditures for social security benefits ( $CSLN$ ) – expenditures of the health insurance scheme prevailing – minus the revenue of the environmental tax reform ( $EGTOE$ ) intended for the cross financing of the pension insurance scheme – to the sum of the gross wages and salaries of private households ( $BLGNH$ ). In the process, the results of the previous period are being referred to. In addition, there is a calibration for the year 2000 ( $Const.$ ).

$$(92) \quad SOZAGSQ[t] = Const[t=2000] * (GSNGNS[t-1] + CSLN[t-1] - EGTOE[t-1] + EGTOE[t=2000]) / BLGSN[t-1]$$



Subsequently, the contribution rates of the industries are projected with regard to the growth factor of the macroeconomic contribution rate:

$$(93) \quad sozagsq_j[t] = sozagsq_j[t-1] * SOZAGSQ[t]/SOZAGSQ[t-1]$$

The multiplication of the sum of gross wages and salaries per employee by the social security contribution rate of the employers results in the labour costs per employee *jlas*:

$$(94) \quad jlas_j[t] = (1 + sozagsq_j[t]) * jls_j[t]$$

The labour demand of the industry *j* – measured by means of the number of employees *bas* – is estimated with regard to the gross production of the sector and the labour costs in constant prices – deflating with the price index of the gross production according to industries *ps* – as well as, in some industries, a time trend.

$$(95) \quad bas_j[t] = f\{xsr_j[t], jlas_j[t]/ps_j[t], ZEIT[t]\}$$

The sum of gross wages and salaries *blgsn* is the product of the sum of gross wages and salaries per employee and the number of employees.

$$(96) \quad blgsn_j[t] = jls_j[t] * bas_j[t]$$

The social security contributions of the employers are ascertained by the multiplication of the respective rates by the sum of gross wages and salaries:

$$(97) \quad sozagsn_j[t] = sozagsq_j[t] * blgsn_j[t]$$

The number of self-employed persons *ses* of a industry often is correlated with the number of employees. At times, however, there is a connection with the gross production or the level of the capital stock of the sector. The number of employed persons *ets* subsequently can be ascertained by definition:

$$(98) \quad ses_j[t] = f\{xsr_j[t], bas_j[t], (kasr_j[t] + kbsr_j[t])\}$$

$$(99) \quad ets_j[t] = bas_j[t] + ses_j[t]$$

The productivity of labour per employee *apb* or per employed person *ape* respectively in prices from 1995 result from the value added *bwsr* as follows:

$$(100) \quad apb_j[t] = 1,000,000 * bwsr_j[t]/bas_j[t]$$

$$(101) \quad ape_j[t] = 1,000,000 * bwsr_j[t]/ets_j[t]$$

The number of employed German nationals *ETI* is estimated with regard to the development of the number of employed persons:

$$(102) \quad ETI[t] = f\{ETS[t]\}$$

The number of unemployed persons *EL* is explained by the development of the exogenous labour force potential *EPP*, the number of employed persons *ETS* and the volume of the exogenous job-creation measures of the Federal Employment Services *APM*:

$$(103) \quad EL[t] = f\{EPP[t], ETS[t], APM[t]\}$$

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The labour force is made up by the employed German nationals  $ETI$  and the unemployed persons  $EL$ . Subsequently, the unemployment rate  $ELQ$  can as well be ascertained by definition:

$$(104) \quad EP[t] = ETI[t] + EL[t]$$

$$(105) \quad ELQ[t] = 100 * EL[t]/EP[t]$$

Finally, the labour force reserves  $STR$  can be ascertained by definition by the subtraction of the number of employed German nationals and the number of unemployed persons from the exogenously determined labour force:

$$(106) \quad STR[t] = EPP[t] - ETI[t] - EL[t]$$

## 2.8 INTEREST RATES

The development of interest rates is dependent on two exogenous preconditions: the effective yield of the US 10 year treasury bonds ( $RUSL$ ) and the base refinancing rate of the European Central Bank ( $RDISK$ ). While  $RUSL$ , within the previous INFORGE versions, had always been exogenous, now  $RDISK$  is equally considered exogenous, since the decisions concerning interest rates by the European Central Bank are binding for the entire Euro zone and, as a consequence, the development in other European countries plays a significant role which, however, cannot be projected by INFORGE.

The interest rate for consumer credits  $RKONT$  and the 10 year treasury bond rate  $RUML$  are explained with regard to the US treasury bond rate  $RUSL$  and the base refinancing rate of the ECB.

## 2.9 SYSTEM OF NATIONAL ACCOUNTS

The model projects the System of National Accounts (Eurostat et al. 1993) in the following structure for Germany: As institutional sectors financial corporations, non-financial corporations, government, private households and non-profit institutions serving households as well as the rest of the world are distinguished. For each institutional sector, the following functional accounts are valid: production, generation of income, allocation of primary income, secondary distribution of income, use of disposable income, and capital.

The system of National Accounts is consistently linked with the input-output module. The behavioural hypotheses of the model concern the expenditures of the institutional sectors. The sums of the revenue of one kind of transaction as well as the account balances always are determined by definition. If the receiving sectors of one kind of transaction are not identified by the econometrically estimated expenditures, this results in an econometric estimation of the structure of revenue with the revenue of one institutional sector (the biggest, in the majority of the cases) being the remainder in order to safeguard consistency.

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## 3 BASE FORECAST

### 3.1 SCENARIO

The base scenario has been developed in spring 2003 and is based on the following assumptions:

- The development of the stock markets is an important indicator for equipment investment (see *CDAXL* in equation 31). For 2003, we expect an increase of 20% and more than a doubling until 2015.
- Consumption expenditures of general government are policy variables (equations 20 and 27): Health care expenditures grow due to demographic change. Pensions depend on revenues of the public pension system, which are driven and interact with the average wage rate. Government expenditures are limited by consolidation efforts to meet the targets of the European stability pact.
- Long-term exchange rate €/US\$ is expected to be near 1. Interest rates will increase again in the long run but are quite stable in 2003 and 2004.
- Labour force potential will decrease in the future due to low historic fertility rates and anticipated immigration according to the 9. population projection of the German Federal Statistical Office (2000). The rising labour participation rate only softens this effect.
- Important developments of foreign trade are depicted by the international INFORUM system. They are exogenous to the model INFORGE. Import prices are expected to grow annually at a low level of 1.2% on average. Average annual growth rates for exports (4.6%) are expected to remain below the high rates in the 1990es.

### 3.2 MODEL RESULTS

#### *Macroeconomic Development*

Figure 1 shows the gross domestic product increasing after the weakness of growth in the years 2001 through 2003, and the growth rates, ranging at about 2%, again reaching the thread that had been realized in the mid 1990s. In the years 2009 - 2011, growth is slightly slowing down.

The component parts of GDP in constant prices will develop highly differently: Exogenously given exports will increase more significantly only from 2004 onward, reaching growth rates of an average 4.6%. Since import demand will increase at about this rate as well, the external balance is by far the most significant factor concerning economic growth.

Figure 1: GDP in Constant Prices of 1995

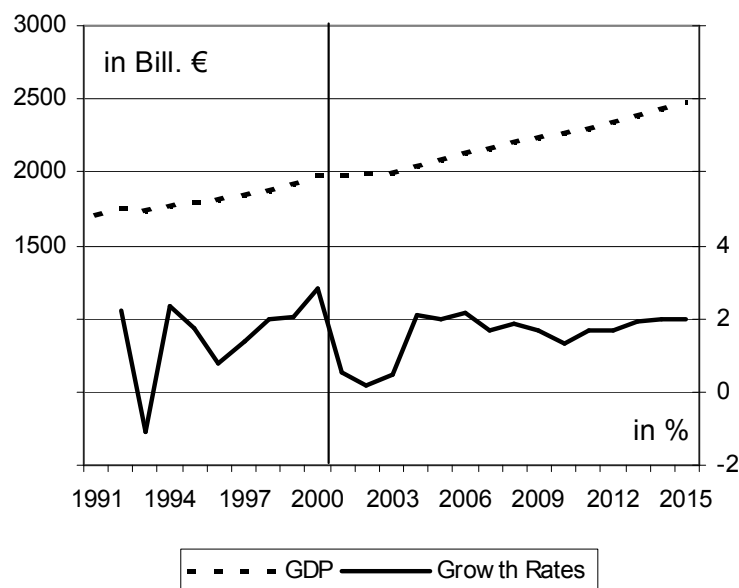


Table 1: GDP and Expenditure Components in Prices of 1995 – (Average) Annual Growth Rates

in Prices of 1995	1991-1995	1995-2000	2001	2002	2003	2000-2005	2005-2010	2010-2015
GDP	1.3	1.8	0.5	0.2	0.5	1.0	1.7	1.8
Private Consumption	1.5	1.7	1.4	-0.5	0.4	1.3	1.6	1.8
Public Consumption	0.7	0.0	-0.7	1.2	-0.5	0.3	1.3	1.1
Social Security Contributions	5.0	3.1	3.2	2.4	1.7	2.0	1.4	1.4
Government Expenditures	2.2	1.2	0.9	1.7	0.4	1.1	1.3	1.2
Equipment Investment	-4.2	6.6	-4.4	-7.2	1.8	-0.4	2.0	1.9
Construction	4.3	-1.3	-5.6	-6.4	-2.5	-3.5	0.5	1.1
Inventories			-0.6	0.1	0.3			
Exports	1.6	8.5	4.9	3.1	2.7	3.9	4.6	4.6
Imports	2.1	7.9	1.0	-1.3	3.1	2.4	4.3	4.6

After two years of downturn, equipment expenditures will experience a positive increase in 2003. On a long-term basis, we expect rates ranging at about 2%. The negative development of construction expenditures will continue further, with, however, decreasing reductions. Inventory investments as well make a positive contribution to macroeconomic growth. This is due to significant inventory liquidation in 2001 and 2002. In 2003, we expect a counter-reaction.

A monitoring of government expenditures shows possibilities of only minor future increases. Especially in 2003, the government is striving for savings. Those are achieved, however, only concerning government consumption which it can influence directly. The social security benefits, especially expenditures of the health insurance scheme on doctors' benefits, medicine and stationary services, on the other hand, show a stronger increase. For 2004 a structural reform of the public health system is envisaged, that has not been considered.

Private consumption in 2004 is reinforced by the income tax reform and will, on a long-term basis, catch up with the development of the gross domestic product. Concerning the available income of the private households, consumption, however, shows a below-average increase, which will result in a rise of the saving rate. This development is predetermined, since in the future an increase in private retirement provision has to be expected.

After the considerable price increases in the course of German reunification, a slow down of the price development followed. This development continues over the years mainly due to low import prices. The general price increase ranges at about 1.2% per year.

### *Government Budget*

Table 2 shows the most significant government revenues and expenditures. The overall income tax still provides the most important tax revenue. Revenue from the value-added tax (VAT) increases constantly. The increases of other commodity taxes, based on the implementation of the environmental tax reform from the year 2000 through 2003, slow down in the course of time.

When you compare the level of social security contributions with the one of monetary social security benefits, it becomes obvious that the monetary social security benefits by far cannot be financed by the social security contributions. A significant reason for that is the development of the “other monetary social security benefits“, which in combination with the “financial benefits of social insurance“ make up the total of the monetary social security benefits. While the “financial benefits of social insurance“ include pension and unemployment benefit payments as well as payments by the health insurance scheme, the “other monetary social security benefits“ are, among other things, retirement pensions, child allowance and social welfare benefits financed by tax means. Thus significant liability increases on the side of the government budget in this area can be ascertained. Moreover, government expenditures keep rising. This is especially due to the government benefits which first and foremost are determined by social security contributions in direct correlation with expenditures by the health insurance scheme. Nevertheless, government will manage to realize an in-balance budget by the end of the simulation period. From the year 2010 onward, even debt relief will be possible.

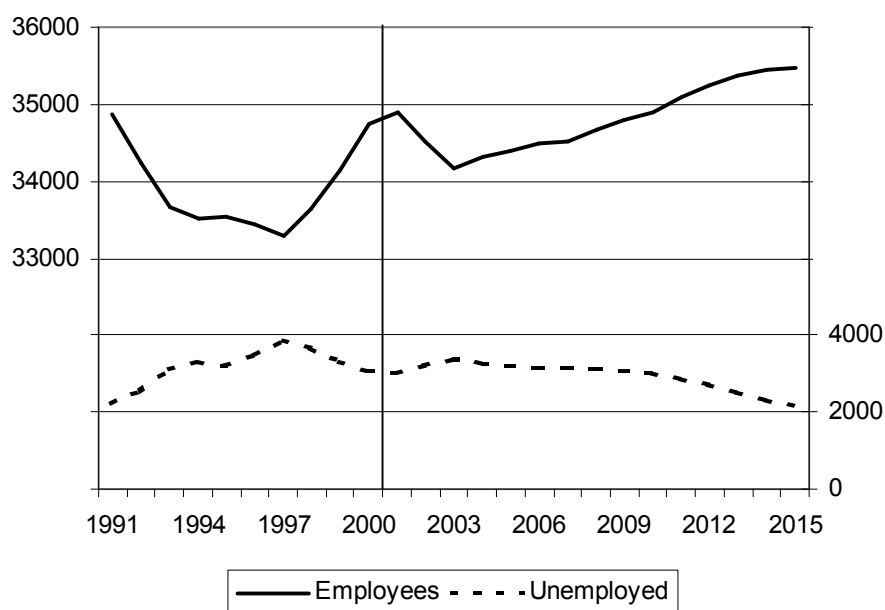
Table 2: The Government Budget

	1991	1995	2000	2001	2002	2003	2004	2005	2010	2015
<b>Revenues in Bill. €</b>										
VAT	86	108	131	132	130	132	135	139	156	179
Other Taxes on Products	40	52	59	72	76	79	79	80	82	85
Income Tax	170	200	254	231	241	246	254	263	322	398
Social Security Contributions	258	339	379	381	388	411	430	451	533	599
<b>Expenditures in Bill. €</b>										
Social Security Benefits	235	325	381	398	423	444	463	482	563	645
Government Expenditures	288	357	387	396	406	414	422	433	491	555
Net Borrowing/Net Lending	-44	-179	23	-47	-55	-44	-37	-30	14	75

There is no extraordinary recovery in the development on the labour market for the years to come. In the year 2003, there still is a downsizing of employment, in the further course of time slight recoveries can be ascertained. Only from 2010 onward, considerable improvement in the development of employment evolves due to demographic change that will reduce the labour force from 2010 onwards. The number of unemployed persons shows a mirror-inverted development. Until 2010, it remains at a high level and then it decreases tangibly.

Despite an average economic growth of about 2%, apparently there is but minor production of jobs. The development of wages, ranging at less than three per cent, is modest. The slow increase in employment first and foremost is due to the level of add-on costs. Especially in the years 2003 through 2004, considerable increases will be at hand. Until 2010, the rates of contribution will keep increasing. Only after that there will be a retrogression, due mainly to the development of the expenditures of the health insurance scheme. On the one hand, the share of older citizens will increase because of the demographic development, on the other hand, the overall population is getting smaller with the result being a decrease in case numbers. These two contrary developments cause a slow down of the increase in overall health benefits. Finally, the basis for assessment of social security contributions increases more significantly than the expenditures (at least as far as public health is concerned). As a consequence, the improving add-on cost situation is one reason for the improving development on the labour market from the year 2010 onward. Labour productivity increases by about 1.5% from 2003 onward. Simultaneously, the annual working time is reduced. Compared to the period from 1991 through 2000, though, this decrease decelerates.

Figure 2: Labour Market in 1000



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### *Sector Development*

The development of *production* in the producing industry will take different directions. The manufacturing industry – reinforced by the considerable development of exports – can keep pace with macroeconomic growth. The construction industry will show but a weak development, the mining industry even will have to suffer further loss. In the service sector, we expect considerable growth in transport and communication as well as financial intermediation. The sectors of real estate, renting and business activities only will grow at an average rate. The background is a weak development in the real estate and renting sector, but considerable growth in business services.

The *value added* in large part parallels the development of production. More significant variances show in manufacturing, hotels and restaurants. The development of the value added in manufacturing will be weaker than that of production, since the trend towards substitution of labour by business services will continue in this sector. Hotels and restaurants will achieve an increase in the share of value added, a development to be interpreted as a quality trend in this sector.

Table 3: Development of Sectors Average Annual Growth Rates

	1991- 1995	1995- 2000	2000- 2005	2005- 2010	2010- 2015
<b>Production in Prices of 1995 in Bill. €</b>					
Agriculture, hunting, forestry, fishery	0.1	2.0	2.1	1.5	1.7
Mining and quarrying	-4.6	-9.9	-0.8	-0.5	-0.3
Manufacturing	-0.4	3.4	1.5	2.0	2.0
Electricity, gas and water supply	0.6	2.4	0.1	1.7	2.0
Construction	5.1	-1.5	-2.6	0.6	1.1
Wholesale and retail trade; repair	0.5	1.9	1.3	2.2	2.7
Hotels and restaurants	0.2	-0.3	-0.8	-0.2	-0.1
Transport, storage and communication	2.3	7.7	2.4	3.3	3.7
Financial intermediation	3.0	8.6	3.0	4.1	4.6
Real estate, renting and business activities	4.1	3.8	1.9	1.9	1.9
Public and private services	2.4	1.5	1.0	1.4	1.4
<b>Value Added in Prices of 1995 in Bill. €</b>					
Agriculture, hunting, forestry, fishery	1.8	2.4	2.4	1.7	2.0
Mining and quarrying	-2.3	-13.0	-1.7	1.0	1.0
Manufacturing	-1.7	0.9	0.6	1.6	1.5
Electricity, gas and water supply	0.8	1.8	0.6	1.7	2.0
Construction	2.5	-2.1	-3.5	0.7	1.2
Wholesale and retail trade; repair	1.3	0.8	0.9	2.0	2.6
Hotels and restaurants	-2.6	-1.3	1.2	0.9	0.9
Transport, storage and communication	3.1	8.3	2.6	3.4	3.8
Financial intermediation	-1.6	-9.6	-2.5	-12.4	-186.5
Real estate, renting and business activities	3.7	4.1	1.8	1.9	1.9
Public and private services	2.2	1.2	0.7	1.2	1.3
<b>Employees in 1000</b>					
Agriculture, hunting, forestry, fishery	-10.3	-0.9	-0.2	-1.0	-1.1
Mining and quarrying	-12.0	-8.1	-4.6	-5.9	-7.5
Manufacturing	-5.7	-0.8	-1.7	-1.4	-1.6
Electricity, gas and water supply	-3.1	-4.0	-1.8	-2.2	-2.3
Construction	3.3	-4.0	-4.3	-1.2	-0.8
Wholesale and retail trade; repair	0.2	1.3	0.5	0.6	0.8
Hotels and restaurants	2.9	5.0	-0.5	-0.7	-0.9
Transport, storage and communication	-3.0	-0.7	-1.0	-0.6	-0.4
Financial intermediation	1.0	0.1	0.1	0.1	0.0
Real estate, renting and business activities	5.7	7.5	3.0	3.1	2.9
Public and private services	1.2	1.0	0.3	0.7	0.6
<b>Labour Productivity in € per Employee in Prices of 1995</b>					
Agriculture, hunting, forestry, fishery	14	3	3	3	3
Mining and quarrying	11	-5	3	7	9
Manufacturing	4	2	2	3	3
Electricity, gas and water supply	4	6	2	4	4
Construction	-1	2	1	2	2
Wholesale and retail trade; repair	1	-1	0	1	2
Hotels and restaurants	-5	-6	2	2	2
Transport, storage and communication	6	9	4	4	4
Financial intermediation	-3	-10	-3	-12	-187
Real estate, renting and business activities	-2	-3	-1	-1	-1
Public and private services	1	0	0	1	1

The development of employment differs from the one of the value added, since the development of the productivity of labour will be highly varying. High productivity increases will result in significant reduction of employment in the whole manufacturing and mining industry. High productivity increases may be expected in the service industries



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of transport and communication as well as lending and insurance. As a result, in spite of the dynamic development of production, stagnation or slight retrogression of employment are likely in these sectors. The sector of real estate, renting and business activities is the one with the most considerable expansion of employment. The increases in public and private services will, of course, take place in the latter sector.

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