

DOCUMENTATION

DINOS – Dynamic Input Output System

The global industry and trade model of Prognos

Author

Jan Limbers

Date

June 2026

Enabling progress. With evidence.

Prognos provides orientation in times of uncertainty. We combine economic research and strategy consulting to enable sound decisions in complex environments. Our robust data, precise analyses and innovative methods support decision-makers in politics, business and society to actively shape change. In this way, we enable progress with substance. For decisions based on evidence.

CEO

Christian Böllhoff

Founding year

1959

President of the Board

Dr. Jan Giller

Working languages

English, German, French

Commercial Register Number

Berlin HRB 87447 B

VAT-ID

DE 122787052

Legal form

Joint stock company (AG) under Swiss law
Registered office of the company: Basel-Stadt
Commercial Register Number:
CH-270.3.003.262-6

.

Our Locations

Headquarter Prognos AG in Switzerland

Prognos AG

St. Alban-Vorstadt 24
4052 Basel
info@prognos.com

X: [Prognos AG](#)

LinkedIn: [@Prognos AG](#)

[prognos.com](https://www.prognos.com)

Further locations in Germany

Prognos AG
Goethestr. 85
10623 Berlin

Prognos AG
Domshof 21
28195 Bremen

Prognos AG
Werdener Straße 4
40227 Düsseldorf

Prognos AG
Heinrich-von-Stephan-Str. 17
79100 Freiburg

Prognos AG
Rödingsmarkt 9
(c/o Mindspace)
20459 Hamburg

Prognos AG
Nymphenburger Str. 14
80335 Munich

Prognos AG
Eberhardstr. 12
70173 Stuttgart

Further location in Belgium

Prognos AG
Résidence Palace, Block C
Rue de la Loi 155
1040 Brussels

Subsidiary company in Austria

Prognos Europe GmbH
c/o e7
Hasengasse 12/2
1100 Vienna

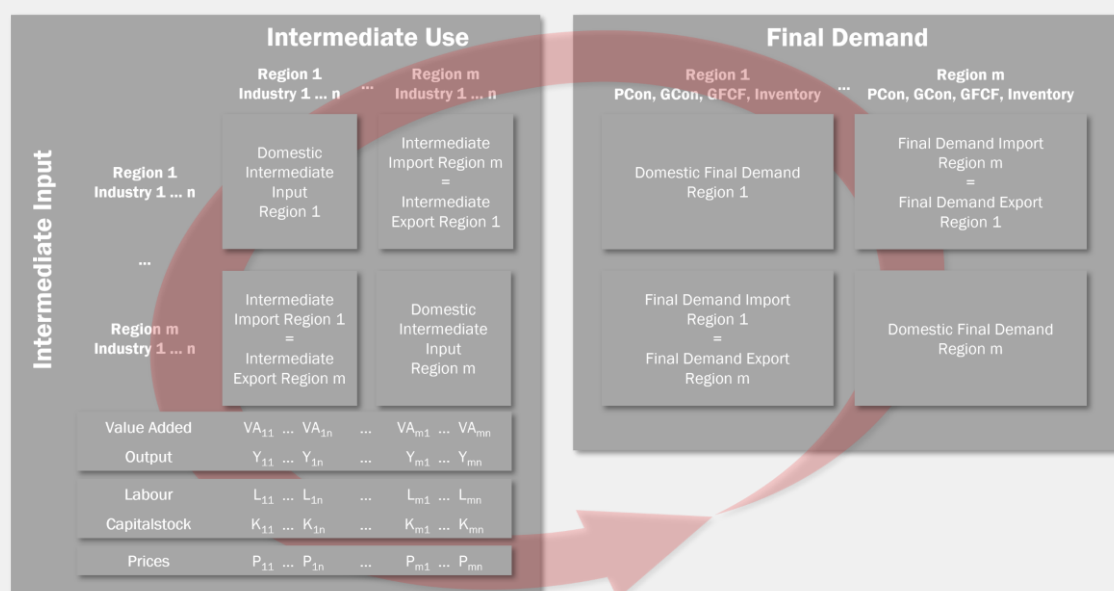
Table of contents

1	DINOS at a Glance	4
2	Modell Description	5
2.1	Basic Structure and Model Solution	5
2.2	Behavioural Assumptions and Institutional Framework	5
2.3	Differences from Computable General Equilibrium (CGE) Models	6
2.4	Flexible Scenario Design	7
2.5	Demography and Labour Market	7
2.6	Capital Stock and Technological Progress	8
2.7	Production Capacity, Price Formation and Wage Setting	8
2.8	Tariff Module	9
2.9	Household Income and Consumption Demand	10
2.10	Endogenous Structural Change and Applications	10
3	References	11
	Annex	12

1 DINOS at a Glance

DINOS – Dynamic Input Output System

DINOS is Prognos' global sectoral and trade model. It is based on the FIGARO database developed and regularly updated by Eurostat. FIGARO provides multiregional input-output tables covering 45 countries (plus a Rest-of-the-World aggregate) and 64 production sectors. Within DINOS, these are aggregated into 36 industries.



DINOS represents the complete circular flow of an economy, capturing the production, distribution, and use of income across industries. Throughout the simulation period, all economic variables are projected forward on an annual basis starting from the current base year 2023. Key economic mechanisms – including wage and price dynamics, technological progress, and the demand for labour and capital – are modelled at the industry level. In addition, the structure of the input-output matrix and, consequently, international trade flows evolve endogenously over time in response to changes in relative prices and costs, demographic developments, and long-term trends. DINOS is particularly well suited for sector-specific and trade-policy analyses. It allows the impacts of a wide range of economic shocks to be assessed not only for the directly affected industry but also for other industries, national economies, and international trading partners. Through its multiregional structure and explicit representation of global value chains, the model captures direct, indirect, and induced effects across industries and countries.

2 Modell Description

DINOS (Dynamic Input Output System) is Prognos' global sectoral and trade model for the analysis of macroeconomic scenarios in internationally interconnected economies. The model is based on multiregional input-output tables from Eurostat's FIGARO database, covering 45 countries plus a Rest-of-the-World aggregate and up to 64 production sectors. For modelling purposes, the latter are aggregated into 36 industries within DINOS. The countries and industries represented in the model are listed in the appendix.

The input-output database is supplemented with additional economic indicators, including population, labour force, employment, and capital stock, compiled from national accounts and international statistical databases such as ILOSTAT and the United Nations Population Prospects. Based on these data sources, a consistent baseline representation of the global economy is constructed for the base year 2023, serving as the starting point for all subsequent simulations.

2.1 Basic Structure and Model Solution

During the simulation period, DINOS represents the complete circular flow of production, income generation, distribution, and expenditure of gross domestic product (GDP), differentiated by countries and industries. The model operates with an annual time step and can be simulated for periods extending up to 2060. Key economic variables – including prices and wages, technological progress, international trade, and the demand for labour and investment goods – are modelled at the industry level. Individual industries are linked through a multiregional input-output matrix, allowing shocks originating either on the demand side (i.e. private and public consumption, investment) or on the cost and supply side to propagate along global value chains. In addition to direct effects within a particular industry, the model therefore captures indirect and induced income and demand effects transmitted through intermediate input linkages.

Unlike static input-output approaches and many computable general equilibrium (CGE) models, DINOS explicitly models economic variables over time. Prices and quantities do not adjust instantaneously to new equilibrium states; instead, they follow endogenously determined adjustment paths. This enables the model to distinguish between short-run and long-run effects of alternative assumptions and policy interventions. Within each simulation year, key quantity variables – including employment, private consumption, investment, output, value added, and working hours – are updated through quarterly iterations. Prices and wages are determined at the beginning of each year, while capital stocks, productivity, labour supply responses, and inflation expectations are updated at the end of the year.

2.2 Behavioural Assumptions and Institutional Framework

The behavioural mechanisms implemented in DINOS are informed by findings from the empirical microeconomic literature. Firms, households, and other economic agents are assumed to exhibit bounded rationality: decisions are made under conditions of incomplete information and are

guided by simple behavioural rules and adaptive adjustment mechanisms. Rather than assuming fully informed optimisation, economic agents respond gradually to changing economic conditions based on observed developments and established decision rules.

DINOS also incorporates key institutional characteristics of modern economies. These include the distinction between firms and private households, the separation of wage income and profit income, and the endogenous creation of credit and money within the modern banking system.

The combination of empirically grounded behavioural assumptions and a realistic institutional framework enable DINOS to capture adjustment processes commonly observed in real-world economies, including delayed responses, imperfect information, path dependency, and feedback effects between the real and financial sectors.

2.3 Differences from Computable General Equilibrium (CGE) Models

DINOS differs from computable general equilibrium (CGE) models in several important respects. First, it adopts a fundamentally different perspective on economic adjustment processes. While many CGE models are primarily designed to determine a new simultaneous market equilibrium following an exogenous shock and often do not explicitly represent the path towards that equilibrium, DINOS models the dynamic adjustment of production, prices, employment, investment, income, demand, and trade structures over time. The transition path is therefore not merely a technical intermediate result but a central object of analysis in its own right.

DINOS also differs from many CGE models in its behavioural assumptions. Traditional CGE frameworks typically rely on representative, optimizing agents, full or highly stylized rationality, and market-clearing mechanisms operating through relative price adjustments. In contrast, DINOS assumes boundedly rational agents that respond according to empirically motivated behavioural rules and with explicit adjustment delays. Economic variables therefore adjust gradually and interactively rather than jumping instantaneously to a new equilibrium.

A further important distinction concerns the treatment of investment and finance. In many neoclassical CGE models, investment is linked to savings or to capital-market clearing consistent with the loanable-funds framework. DINOS does not adopt this perspective. Instead, investment is modelled as a real-economic adjustment process determined by depreciation, capital stock requirements, employment developments, productivity growth, demand expectations, profitability, and financing conditions. In doing so, DINOS reflects the functioning of modern monetary economies, in which lending and investment are not mechanically constrained by a pre-existing pool of household savings. Rather, bank deposits are predominantly created through commercial bank lending: when a loan is issued, both a bank asset and a corresponding deposit are created simultaneously. Savings are therefore not viewed as a necessary ex-ante prerequisite for investment but emerge ex post from the income generated by credit-financed expenditure and investment.

In addition, DINOS explicitly incorporates real-world frictions and capacity constraints. Labour markets are not assumed to clear through fully flexible wages. Instead, labour market dynamics evolve through changes in working hours, employment, labour-force participation, and labour market tightness. Production capacity is determined by employment, normal working hours,

productivity, and capital stocks. International trade structures respond not only to relative prices but also to capacity utilization. This allows supply bottlenecks, supply-chain disruptions, and international spillover effects to be represented more realistically.

As a result, DINOS generates dynamic scenario trajectories that are particularly valuable for policy analysis. The model not only quantifies long-run differences in economic outcomes but also reveals through which real-economic channels, with what adjustment lags, and through which feedback mechanisms shocks propagate over time across industries, countries, incomes, demand components, and international trade networks.

2.4 Flexible Scenario Design

A key feature of DINOS is its high degree of flexibility in specifying shocks and designing alternative scenarios. Policy interventions and exogenous shocks can be introduced at virtually any stage of the economic cycle. These range from changes in final demand, such as adjustments in private or public consumption and investment activity, to cost-side and supply-side shocks, including changes in prices, wages, productivity, or production capacities within individual industries. Structural changes in capital stocks and demographic developments can also be incorporated directly into the modelling framework.

In addition, DINOS allows for the analysis of trade policy measures and other external economic interventions affecting import and export flows as well as international competitiveness. This includes, in particular, tariff scenarios, in which tariff rates are implemented as price mark-ups on international trade flows. The resulting effects on relative prices, trade shares, intermediate input costs, production, and demand can then be analysed consistently within the model framework.

Because all shocks are embedded within a coherent macroeconomic accounting framework, DINOS can be used to analyse both isolated policy measures and complex combinations of multiple interventions. The model therefore provides a flexible platform for constructing and comparing alternative economic scenarios. Typical applications include the evaluation of subsidy and investment programmes, the analysis of supply-side and demand-side shocks, and industrial and structural transformation policies characterised by substantial international spillover and feedback effects.

2.5 Demography and Labour Market

Population developments are treated as exogenous and are differentiated by age and gender. In most applications, DINOS relies on the population projections published by the United Nations (currently the UN Population Prospects 2024). Alternative demographic projections from other sources can be incorporated with relatively little effort. The labour force is determined by demographic developments and age- and gender-specific labour force participation rates. These participation rates may adjust endogenously over time in response to labour market conditions, with groups exhibiting initially low participation rates responding more strongly to increases in labour demand.

A demographic decline in the labour force is allocated proportionally between employed and unemployed persons. Firms attempt to offset any resulting reduction in employment by recruiting workers from the pool of unemployed individuals. In determining their labour demand, firms also take into account the gap between actual and normal working hours. Desired hiring and dismissal decisions are derived from this gap through an adjustment mechanism that includes a time lag. Reductions in employment are implemented immediately and fully. The extent to which desired hiring can be realised decreases as the resulting unemployment rate approaches an exogenously specified minimum level (i.e. structural or frictional unemployment). Capacity utilisation is approximated by the ratio of actual to normal working hours.

The chosen labour market specification has several important implications:

- Short-term positive demand shocks primarily increase actual working hours on a temporary basis, while employment levels respond only to a limited extent.
- If demographic constraints on labour supply can no longer be compensated through additional hiring, capacity utilisation in the affected industry rises above its normal level, as approximated by the ratio of actual to normal working hours. In this case, the model generates negative feedback effects that dampen demand for the industry's output.
- An increase in normal working hours or labour force participation rates resulting from a policy intervention raises unemployment under conditions of a constant population, without directly affecting employment.
- Countries experiencing strong growth in their working-age population tend to face rising unemployment rates over the simulation horizon.

2.6 Capital Stock and Technological Progress

The capital stock is updated annually through depreciation and gross fixed capital formation. Gross investment depends on the depreciation rate, the capital intensity of the existing capital stock (measured as capital stock per employed person), and the realised level of employment, each determined at the industry level. As a consequence, demographic constraints on employment growth exert a dampening effect on investment activity.

In DINOS, technological progress is embodied in capital. Newly installed capital goods are assumed to exhibit higher labour productivity (value added per hour worked) and a higher capital-labour ratio than the existing capital stock within an industry. As the capital stock is gradually renewed, industry-specific labour productivity and capital intensity increase accordingly. For the technological progress embodied in new capital goods, the model assumes an international convergence process in which technologically less advanced countries and industries experience higher rates of productivity growth than those operating closer to the technological frontier.

2.7 Production Capacity, Price Formation and Wage Setting

In DINOS, production requirements arising from final demand are constrained by available production capacities. Capacity utilisation is approximated by the ratio of actual working hours to normal working hours. When industries operate above their normal capacity level, firms respond by increasing their mark-up on production costs. At the same time, trade shares react not only to

changes in relative prices but also to capacity constraints faced by suppliers. Following adjustments in bilateral trade shares, the resulting trade structure is rescaled to maintain the predefined aggregate industry structure, thereby preserving sectoral consistency and intra-industry trade patterns. As a consequence, industries experiencing persistent overutilisation gradually lose market shares both domestically and internationally, contributing to a deterioration of the trade balance.

Prices and nominal hourly wages are determined separately for each industry at the beginning of every year. Wage formation is influenced by past productivity growth, expected inflation, and the degree of labour market tightness. Cost shocks are passed through to prices only gradually. An error-correction mechanism ensures that realised mark-ups on average production costs converge over time towards firms' target mark-ups. Unit production costs consist of labour costs, nominal intermediate input costs, and capital costs. Changes in relative prices are translated into changes in trade shares through industry-specific price elasticities, while cost developments affect target margins and production prices with a time lag.

The interaction between capacity utilisation, wage formation, price dynamics, and international competitiveness constitutes an important adjustment mechanism within DINOS. Changes in costs and prices influence not only domestic production decisions but also international trade patterns, creating feedback effects between capacity constraints, competitiveness, and economic growth across industries and countries.

2.8 Tariff Module

DINOS includes a tariff module for representing trade policy interventions in the form of ad valorem tariffs on international trade flows. Tariff rates are modelled as proportional price surcharges applied to bilateral flows of goods and services. The model distinguishes between tariffs on intermediate input flows within the multiregional input-output matrix and tariffs on deliveries to final demand. Tariff rates can be specified by country of origin, industry of origin, destination country, and destination industry. A tariff increases the effective purchasing price of the affected imports. As a result, the nominal intermediate input costs of the importing industry initially increase. Through the model's cost and price formation mechanisms, these effects may subsequently be passed on to production prices with a time lag. At the same time, tariffs affect the relative prices of alternative supplier countries and thereby alter the international sourcing structure.

Trade shares adjust according to a rule-based mechanism driven by relative price changes. When the effective price of imports from a particular country increases as a result of a tariff, that country's share of total intra-industry imports declines according to the industry-specific price elasticity of import demand. The resulting bilateral trade shares are subsequently rescaled to the predefined aggregate industry structure. Consequently, DINOS does not model import demand through a fully specified microeconomic optimisation framework, but rather through a dynamic, price-driven reallocation process within the existing input-output structure.

Through the multiregional structure of the model, tariffs affect not only the directly targeted trade flows but also generate indirect effects along international value chains. Higher import prices increase production costs in downstream industries, alter profit margins, and may influence

consumption, investment, and export prices through delayed cost pass-through. These adjustment processes create feedback effects on real demand, production, employment, income, and international trade.

2.9 Household Income and Consumption Demand

Private households derive income primarily from employment. In addition, a share of gross operating surplus is distributed to households as profit income. Households determine their consumption and saving decisions according to a country-specific and income-specific target relationship between their stock of wealth and their expected trend income from employment, following a buffer-stock saving rule.

Under this behavioural framework, households adjust their expenditure gradually in response to changes in income and wealth. Consumption therefore depends not only on current income but also on households' desired wealth position and their expectations regarding future income developments. This approach enables the model to capture dynamic interactions between income generation, wealth accumulation, saving behaviour, and aggregate demand.

Government consumption and the expenditure of non-profit institutions serving households are projected forward in line with developments in productivity and population. As a result, trends in demographic change and economic growth influence not only production and employment but also the evolution of final demand.

2.10 Endogenous Structural Change and Applications

Throughout the simulation period, changes in relative prices and costs, demographic developments, and long-term trends give rise to endogenous adjustments in demand, production, and trade structures within the multiregional input-output matrix. These structural changes do not occur freely but are governed by defined adjustment mechanisms, including autonomous industry-specific trends, relative price movements, capacity utilisation, and the normalisation of bilateral trade patterns to predefined aggregate industry structures. As a result, bilateral trade relationships and demand shares can evolve over time while maintaining consistency with the overall sectoral structure of the economy.

This framework makes DINOS particularly well suited for the analysis of sector-specific and cross-country economic questions in which both direct and indirect macroeconomic effects need to be quantified. In addition to capturing direct impacts on affected industries, the model also accounts for indirect and induced effects transmitted through global value chains, income generation processes, and international trade linkages.

Typical applications of the model include the assessment of subsidy and investment programmes, the analysis of external supply and demand shocks, as well as industrial, trade, and structural transformation policies characterised by significant international spillover and feedback effects. Through its dynamic simulation framework, DINOS enables the analysis not only of long-term outcomes but also of the adjustment processes through which economic shocks propagate across industries, countries, and economic actors over time.

3 References

Shoven, J. B.; Whalley, J. (1984): Applied General-Equilibrium Models of Taxation and International Trade: An Introduction and Survey. *Journal of Economic Literature*, 22(3), 1007–1051.

Shoven, J. B.; Whalley, J. (1992): *Applying General Equilibrium*. Cambridge University Press.

Hertel, T. W. (Hrsg.) (1997): *Global Trade Analysis: Modeling and Applications*. Cambridge University Press.

Dixon, P. B.; Parmenter, B. R.; Sutton, J.; Vincent, D. P. (1982): *ORANI: A Multisectoral Model of the Australian Economy*. North-Holland.

Dixon, P. B.; Rimmer, M. T. (2002): *Dynamic General Equilibrium Modelling for Forecasting and Policy: A Practical Guide and Documentation of MONASH*. North-Holland.

Löfgren, H.; Harris, R. L.; Robinson, S. (2002): *A Standard Computable General Equilibrium (CGE) Model in GAMS*. IFPRI, *Microcomputers in Policy Research* 5.

McLeay, M.; Radia, A.; Thomas, R. (2014): *Money creation in the modern economy*. Bank of England Quarterly Bulletin, 2014 Q1.

Annex

Appendix A1: Country and Industry Coverage in DINOS

European Union Countries		Industries	
AT	Austria	A	Agriculture, Forestry and Fishing
BE	Belgium	B	Mining and Quarrying
BG	Bulgaria	C10T12	Food Products, Beverages and Tobacco
CY	Cyprus	C13T15	Textiles, Apparel, Leather and Leather Products
CZ	Czech Republic	C16	Wood, Cork, Straw and Plaiting Products
DE	Germany	C17	Paper and Paper Products
DK	Denmark	C18	Printing and Recorded Media
EE	Estonia	C19	Coke and Refined Petroleum Products
ES	Spain	C20	Chemicals and Chemical Products
FI	Finland	C21	Pharmaceuticals
FR	France	C22	Rubber and Plastic Products
GR	Greece	C23	Other Non-Metallic Mineral Products
HR	Croatia	C24	Basic Metals
HU	Hungary	C25	Fabricated Metal Products
IE	Ireland	C26	Computer, Electronic and Optical Products
IT	Italy	C27	Electrical Equipment
LT	Lithuania	C28	Machinery and Equipment
LU	Luxembourg	C29	Motor Vehicles, Trailers and Semi-Trailers
LV	Latvia	C30	Other Transport Equipment
MT	Malta	C31T33	Other Manufacturing
NL	Netherlands	D	Electricity, Gas, Steam and Air Conditioning Supply
PL	Poland	E36	Water Collection, Treatment and Supply
PT	Portugal	E37T39	Sewerage, Waste Management and Remediation Activities
RO	Romania	F	Construction
SE	Sweden	G	Wholesale and Retail Trade; Repair of Motor Vehicles
SI	Slovenia	H	Transportation and Storage
SK	Slovakia	I	Accommodation and Food Service Activities
Other Countries		J	Publishing, Telecommunications and Information Services
AR	Argentina	K	Financial and Insurance Activities
AU	Australia	L	Real Estate Activities
BR	Brazil	M	Professional, Scientific and Technical Activities
CA	Canada	N	Administrative and Support Service Activities
CH	Switzerland	O	Public Administration, Defence and Social Security
CN	China	P	Education
UK	United Kingdom	Q	Human Health and Social Work Activities
ID	Indonesia	R_U	Other Services
IN	India		
JP	Japan		
KR	South Korea		
MX	Mexico		
NO	Norway		
RU	Russia		
SA	Saudi Arabia		
TR	Türkiye		
US	United States		
ZA	South Africa		
FIGW1	Rest of the World		

Imprint / Disclaimer

DINOS – Dynamic Input Output System

The global industry and trade model of Prognos

Published by

Prognos AG
Heinrich-von-Stephan-Straße 17
79100 Freiburg
Telefon: +49 761 7661164-810
E-Mail: info@prognos.com
www.prognos.com

Contact

Jan Limbers
E-Mail: jan.limbers@prognos.com

Composition and layout: Prognos AG
Status: June 2026
Copyright: 2026, Prognos AG

All contents of this work, in particular texts, illustrations and graphics, are protected by copyright. The copyright is, unless expressly indicated otherwise, in the Prognos AG. Any kind of duplication, distribution, public access or other use requires the express, written consent of Prognos AG.