Contents

A V	mployment Effects of Modern Technology Wide Range of Empirical Findings and Competing Approaches of Analytical egration
Ro	nald Schettkat and Michael Wagner
1.	Technology Indicators.11.1 Measuring Technical Progress.21.2 Value Units as Indicators.31.3 Innovation Indicators Used in the Meta Study.4
2.	The Effects of Modern Technology on the Level of Employment 5
3.	Changes in Skill Profiles
4.	Functional Relationships between Various Areas of Analysis
5. Pa	Outlook
En	ne Effects of the Use of Computer-Aided Technology in Industrial interprises. It's the Context that Counts ins-Jürgen Ewers, Carsten Becker and Michael Fritsch (Institut für
	adtforschung und Strukturpolitik Berlin)
1.	Introduction
2.	The Data Base
3.	The Diffusion of Computer-Aided Technology
	- · · · · · · · · · · · · · · · · · · ·

VIII Contents

4	The	Effects of Computer-Aided Technology	39
••	4.1	The Overall Effects of Computer-Aided Technology at	
		Enterprise Level	39
	4.2	The Effects of the Use of Computer-Aided Technology	
		in Individual Departments	43
		4.2.1 Effects of the Use of CAD Technology	45
		4.2.2 The Effects of the Use of CNC Technology	47
	4.3	Determinants of the Effects of Computer-Aided Technology	48
		4.3.1 Determinants of the Effects of CAD Technology	48
		4.3.2 Determinants of the Effects of CNC Technology	
5.	Dire	ect Quantitative Employment Effects of Computer-Aided Technology	52
	5.1	The Structure of the Employment Effects of the Use of	
		Computer-Aided Technology	53
	5.2	The Level of the Direct Employment Effects of Computer-Aided	
		Technology	54
	5.3	Determinants of the Direct Quantitative Employment Effects	56
6.	Ret	raining as a Consequence of the Use of Computer-Aided	
٥.	Tec	hnology and its Problems	57
7		the Effects of the Use of Computer-Aided Technology on	
7.	Un Em	ployment Trends at Enterprise Level	60
	Em	proyment Trends at Enterprise Bever	
TL	. D:	ffusion of New Technologies and their Effects in the	
		Service Sector	
		öflich-Häberlein and Hubertus Häbler (Infratest	
So	u III zialfa	orschung München)	65
50.	- Luije	The second of th	65
1.		a Sources and Analytical Methods	05
2.	Mo	tives for the Introduction of Micro-electronics and its Effects	
	at E	Enterprise Level	66
	2.1	Productivity and the Service Sector	00.
	2.2	Motives for the Introduction of Micro-electronics	68
	2.3	Rationalization through the Use of Micro-electronics	70
	2.4	Systemic Innovations through the Use of Micro-electronics	/U
	2.5	The Motives for the Use of Micro-electronics in Different	72
		Departments within the Enterprise	12
	2.6	The Motives for the Use of Micro-electronics in Selected	75
		Branches	./3 75
		261 Banks	13

Contents IX

		2.6.2 Retail and Wholesale Trade
		2.6.3 Engineering and Architectural Offices
	2.7	The Effects of the Use of Micro-electronics on Enterprise
		Performance
3.	Inne	r-enterprise and Intra-enterprise Diffusion of
		ro-electronics
		The Determinants of the Diffusion Process in Different Branches 80
	3.2	Diffusion within the Enterprise
		The Use of New Technology in the Different Departments
		Diffusion in Selected Branches
		3.4.1 Banking
		3.4.2 Wholesale Trade/Freight Forwarding
		3.4.3 Travel Agencies and Tour Operators
		3.4.4 Engineering and Architectural Offices
4.	The	Employment Effects of the Use of Micro-electronics
•	4.1	Department Analyses in Selected Branches
		4.1.1 Department Analysis in the Banking Sector
		4.1.2 Department Analysis in Financial Service Enterprises 90
		4.1.3 Department Analysis in Wholesale Trade and Freight
		Forwarding Companies
	4.2	The Employment Effects of Product and Process Innovations 10
	4.3	The Effects of the Use of Micro-electronics on the Skills and
		Qualifications of the Work Force
	_	s in Enterprise Size and Employment Levels in the Branches of the
		Republic of Germany 1980 to 1986
	_	tudinal Analysis of Employment in Enterprises Active between 1980 and New" and "Non-Surviving" Enterprises
		König and Gernot Weißhuhn, in collaboration with Jürgen Seetzen
(Te	chnis	sche Universität Berlin/Heinrich-Hertz-Institut Berlin)11
1.	Intro	oduction
2	Data	Base and Method
۷.		Employment Statistics
		The Consistency of Data in the Case of a Change of Branch
		Evaluation

X		Contents

3.	The Major Empirical Results	122
4.	Summary and Outlook	131
Ра	RT II: INDUSTRIES	
In	ovation, Growth and Employment	
	ovative Activity at Plant, Sectoral and Intersectoral Level and its Effects he West German Economy in the 1980s	
Lo	har Scholz, Horst Penzkofer and Heinz Schmalholz in Collaboration	
wit	n Jörg Beutel (Ifo-Institut für Wirtschaftsforschung, München)	
1.	The Theoretical Framework	135
2.	The Methodological Approach	136 137
3.	Data Base	139 139
4.	Empirical Results	145 150 150
5.	Innovation Indicators	

Contents XI

	ne Effects of Research and Development on Employment, Prices
	d Foreign Trade
	org Erber and Gustav A. Horn (Deutsches Institut für
Wi	rtschaftsforschung Berlin)
1.	Introduction
2.	The Employment Effects of Technological Change
	2.1 Econometric Estimates
	2.2 Rationalization Effects
	3. The Price Effects of Technological Change
	4. The Effects of Technological Change on Foreign Trade
	4.1 R&D Activity in the Federal Republic, Japan and the USA
	4.2 Direct Effects of R&D Activity on the Foreign Trade
	Relations of Selected Sectors
	4.3 The Employment Effects of Increased R&D Activity on
	Foreign Trade
	4.3.1 The Assumptions of an Ex-post Scenario of Increased
	R&D Activity
	4.3.2 Employment Effects Induced by Foreign Trade
5	Conclusion
٥.	Conclusion
Sto Pe Ko	te Labor Market Effects of New Technologies - an Econometric udy for the Federal Republic of Germany ter Kugler, Urs Müller and George Sheldon (Basler Arbeitsgruppe für onjunkturforschung/Forschungsstelle für Arbeitsmarkt- und dustrieökonomik der Universität Basel)
1.	Introduction
2	The Theoretical Approach
2.	
3.	The Empirical Procedure
4.	The Results of the Estimation
5.	Summary and Conclusions

XII Contents

Jü	chnological Change and Employment Structures rgen Warnken and Gerd Ronning (Institut für Sozialforschung und sellschaftspolitik Köln)	5
1.		
1. 2.	Activity Structures and the Diffusion of New Technology in	J
	the Enterprise	6
	2.1 The Occupational Structure of Labor Input	9
	2.2 Activity Structures in Different Branches	
3.	The Institutional Framework and the Use of New Technology	
٠.	3.1 Industrial Relations and the Use of New Technology	
	3.1.1 Trade Unions, Collective Bargaining and Innovation 23	
	3.1.2 Industrial Relations at Plant Level and their	1/1
	Influence on the Use of Technology	4
	and the Use of New Technology	ıΩ
	3.2 Age-specific Displacement of Labor	.9
Ro	novation and Labor Market Dynamics nald Schettkat and Bettina Bangel (Wissenschaftszentrum Berlin für zialforschung/Arbeitsmarkt und Beschäftigung)	55
	Introduction	
	Labor Market Processes: Mobility and Flexibility,	
۳.	Flow and Stock Values	7
3.	The Risks of Unemployment	
٥.	3.1 The Components of Unemployment	1
	3.2 The Risk of Becoming Unemployed by Branch	3
4.	The Risk of Becoming Unemployed and Innovation	
	4.1 Indicators of Innovation	7
	4.2 The Analytical Model	9
	4.3 Operationalization	1
5.	Empirical Analysis of the Relationship between the Risk of Becoming	
	Unemployed and Innovation	2
	5.1 Other Factors Influencing the Risk of Becoming Unemployed 27	2
	5.2. The Results of the Analysis	

Co	ntents X	III
6.	The Flow out of the Active Labor Force	30
7.	The Elasticity of the Supply of Labor by Occupational Group	34
8.	A Summary of Our Conclusions	38
Ра	RT III: MACRO-ECONOMICS	
To Die	ersectoral Effects of the Use of Industrial Robots and CNC-Machine ols - An Empirical Input-Output Analysis etmar Edler, Renate Filip-Köhn, Frieder Meyer-Krahmer, Reiner Stäglin de Hans Wessels (Deutsches Institut für Wirtschaftsforschung Berlin) 29	93
1.	Introduction)3
2.	The Effects of the Use of Industrial Robots and CNC Machine Tools - Calculations Using a Static Input-output Analysis	94 98
3.	The Effects of the Use of Industrial Robots to 1995 - Model Calculations using a Dynamic Input-output Approach)1)4)8
We	NDEM: Simulations within the Innovation-Growth-Employment-Circuit rner Frühstück and Michael Wagner (Institut für Wirtschafts- und ialforschung Wien)	.5
1.	Functional Relationships	6
2.	The Two Versions of Tandem	22
3.	Innovation and Investment	30

XIV	Co	ntents

4.	Accumulation and Absorption of Technical Knowledge
5.	The Effects on Productivity
6.	Patterns of Macroeconomic Adjustment
7.	Selected Simulations
8.	Outlook
of	rspectives for Macro-Economic Development at Different Rates Innovative Activity rgen Blazejczak (Deutsches Institut für Wirtschaftsforschung
Be	rlin)
1.	Introduction
2.	The Extent of the Primary Effects of an Increase in Innovative Activity
3.	Scenarios of Increased Innovative Activity
	National Product
4.	Reduced Innovative Activity - An Illustrative Scenario
5.	Conclusions
Ref	ferences
The	e Authors

Tables and Figures

Employment Effects of Modern Technology A Wide Range of Empirical Findings and Competing Approaches of Analytical Integration (Schettkat/Wagner):			
Table 1.1:	Innovation Concepts, Survey and Analysis Levels		
Figure 4.1:	A Survey of the Meta Study's Analytical Areas		
	of the Use of Computer-Aided Technology in Industrial Enterprises. stext that Counts (Ewers/Becker/Fritsch):		
Table 3.1:	Adoption Rates for Computer-Aided Technologies by Branches of Industry (%)		
Figure 3.1:	Rank Order of Motives for the Introduction of Computer-Aided Technology		
Table 3.2:	Answers to the Question "Why didn't you introduce more computer-aided technology?" (in %)		
Table 4.1:	Answers to the Question "Which effects of the introduction of computer aided technologies have been observed or are expected in this plant?"		
Table 4.2:	Answers to the Question "Did the use of computer-aided technology lead to changes in plant-organization?" (%)		
Table 4.3:	Answers to the Question: "What do you see as the major disadvantages resulting from the introduction of computer-aided technology?		
Table 4.4:	Answers to the Question "How did the time required for certain design-activities change due to the use of CAD compared to conventional design methods?"		
Table 4.5:	Effects of the Use of Computer-Aided Design		
Table 4.6:	Answers to the Question "How did the time needed for production change due to use of CNC-equipment"		
Table 4.7:	Effects of CNC Use (answers in %)		

XVI Contents

Table 5.1:	Structure of the Employment Effects of the Use of Computer-Aided Technology at Plant Level	53
Table 5.2:	Structure of Exits due to the Introduction of Computer-Aided Equipment	54
Table 5.3:	Gross-Labor Movement due to the Introduction of Computer-Aided Technology at Plant Level	55
Table 5.4:	Structure of Technology Linked Labor Movements due to the Introduction of Computer-Aided Technologies in Different Departments of German Manufacturing Plants	55
Table 6.1:	Proportion of Retrained Employees According to Initial Qualifications and Duration of Retraining to the Total of all Retrained Employees (by initial qualification)	58
Table 6.2:	Problems Experienced in Retraining Personnel	59
	on of New Technologies and their Effects in the Private tor (Höflich-Häberlein/Häbler):	
Table 1.1:	Respondents in the Survey by Branch	66
Table 2.1:	The Uses and Aims of Technology by Department - User Enterprises	73
Table 2.2:	The Most Important Effect of the Use of Technology - Banks and Non-Banks	78
Table 2.3:	Anticipated Effects of the Use of New ICTs on the Enterprise - Threshold Users	78
Table 2.4:	Actual and Expected Effects of the Use of New Technology on the Quality of Products/Services - Banks, Non-Banks, Threshold Users	79
Table 3.1:	The Use of ICT in the Enterprise - by Branch, in %	81
Table 3.2:	Terminals per Employee by Branch and Enterprise Size, 1982 and 1985 - User Enterprises	
Table 3.3:	Proportion of White-Collar Workers Using Data Processing and Word Processing Equipment - by Branch, 1982 and 1985	

Contents	XVI
Table 3.4:	The Use of Technology by Department (in %) - User Enterprises
Table 3.5:	Direction of the Reorganization of User Enterprises (in %) - Banks and Non-Banks
Table 4.1:	The Effects of the Use of Technology on Service - Wholesale Trade and Freight Forwarding Companies
Table 4.2:	The Effects of the Use of New Technology on the Skills and Qualifications of the Work Force - Banks and Non-Banks
Federal Rep Employmen	Enterprise Size and Employment Levels in the Branches of the public of Germany 1980 to 1986. A Longitudinal Analysis of it in Enterprises Active between 1980 and 1986, "New" and ving" Enterprises (König/Weißhuhn):
Table 1.1:	Sector 08 Iron, Steel, Nonferrous Production
Table 1.2:	Sector 37 Private Law and Business Services, Architecture, Engineering
Table 2.1:	Selected Changes of Economic Sectors
Figure 2.1:	Number of Enterprises and Employment Gains and Losses (absolute)
Table 3.1:	Sectoral Development of Employment in the Federal Republic of Germany 1980 - 1986

Development of Employment 1980 to 1986 by Economic Sectors and Categories of Size of Enterprises in "Survivor" Enterprises,

in "New" and in "Non-Survivor" Enterprises

Relative Indices of the Development of Employment 1980 - 1986 by Economic Sectors and Categories of Size

Table 3.2:

Table 3.3:

and Interse	, Growth and Employment. Innovative Activity at Plant, Sectoral ectoral Level and its Effects on the West German Economy s (Scholz/Penzkofer/Schmalholz/Beutel):
Table 3.1:	Number of Firms/Enterprises in Ifo Tests 1979 to 1986 140
Figure 3.1:	
Table 3.2:	Expenditure on Investment and Innovation in Manufacturing Industry 1962 to 1986 - mill. DM
Figure 3.2:	
Table 4.1:	The Aims of Product Innovators in Manufacturing Industry 1982 - 1986
Table 4.2:	The Aims of Process Innovators in Manufacturing Industry 1982 - 1986
Table 4.3:	The Source of Ideas for Innovation in Manufacturing Industry 1982 - 1985
Table 4.4:	Barriers to Innovation Reported by Non-Innovators 1982 - 1986
Table 4.5:	Barriers to Innovation Reported by Innovators 1982 - 1986
Table 4.6:	Expenditure on Innovation in Manufacturing Industry by Branch 1979 - 1986
Table 4.7:	Expenditure on Product Innovation in Manufacturing Industry by Branch 1979 - 1986
Table 4.8:	Expenditure of Product Innovation in 1980 and Turnover Share of Products in the "Market Introduction" Phase in 1986
Table 4.9:	Innovative Behavior over Time
	Employment and Turnover between 1979 and 1986, Innovative and Non-Innovative Enterprises
Table 4.11:	Expenditure on Innovation and Economic Growth
	Changes in Employment and Gross Value-added in Different Types of Innovation Flow (1980 - 1986)
Figure 4.1:	Intersectoral Innovation-Bundle of the German Industry (1980)

contents			XIX

Figure 4.2:	Intersectoral Innovation-Bundle of the German Industry (1986)
Figure 4.3:	
Table 4.13:	The Innovation Budget of the FRG 1980 to 1986
	Innovative Content of Final Demand
	Innovative Content (product innovation) of Final Demand 163
Table 5.1:	Innovation Indicators for the Federal Republic of Germany
Table 5.2:	Innovation Indicators for Selected Sectors (1986)
Table 5.3:	The Technological Areas of Current Innovative Activity (1986)
Table 5.4:	The Technological Areas of Future Innovative
	Activity
The Effects of Foreign Tra	of Research and Development on Employment, Prices and de (Erber/Horn):
Table 2.1:	Employment Effects - FRG except public sector
Table 2.2:	Rationalization Quotient by Sector
Table 4.1:	Chemical Sector incl. Production and Processing of Fossile Material
Table 4.2:	Mechanical Engineering
Table 4.3:	Automobile Industry
Table 4.4:	Electrical Engineering
The Labor M Study for the	larket Effects of New Technologies - an Econometric Federal Republic of Germany (Kugler/Müller/Sheldon):
	The Bias of Technical Progress
Γable 4.2:	The Bias of Technical Progress: White-Collar Workers
Table 4.3:	The Bias of Technical Progress:
	Dive-Collar workers 207

XX Contents

Table 4.4:	Substitution between White-Collar Workers (W), Blue-Collar Workers (B) and Equipment (E)
Table 4.5:	The Relative Importance of Changes in Factor Prices and the Bias of Technical Progress for Changes in the Structure of Labor Cost Shares
Technologic	cal Change and Employment Structures (Warnken/Ronning):
Table 2.1:	A Branch Typology by Innovative Activity
Figure 2.1:	The Determinants of Changes in Employment in Manufacturing Industry - selected skill levels
Figure 2.2:	The Changes in Employment in Technical Occupations - 1980 to 1985
Table 2.2:	Changes in the Employment of Technical Occupations in Selected Branch Groups - 1980 to 1985
Figure 2.3:	Clerical Workers and Innovation - changes between 1980 and 1985
Table 2.3:	Employment Trends in Managerial Occupations 1980 to 1985
Table 2.4:	Changes in Overall Occupational Structure* 1980 to 1985 225
Table 2.5:	A List of the Activity Categories and their Aggregation into Occupational Groups
Figure 2.4:	Changes in Proportion of the Work Force Employed in Selected Occupational Functions of Manufacturing Industry, 1980 to 1985
Table 2.6:	Changes in Office Activities 1980 to 1985
Table 2.7:	The Status of Workers within the Enterprise in Manufacturing Industry in 1980 and the Changes between 1980 and 1985 233
Figure 2.5:	Activity Profiles in Selected Branch Groups - manufacturing industry, 1980
Table 2.8:	Changes in the Share of Skilled Workers by Branch Group - dynamic, hesitant and weak innovators 1980 to 1985
Figure 3.1:	The Determinants of the Use of Technology with their Direction of Influence

ontents	XXI

Table 3.1:	Protection from the Effects of Rationalization in Different Branches
Figure 3.2:	
Figure 3.3:	
Figure 3.4:	
Innovation	and Labor Market Dynamics (Schettkat/Bangel):
Figure 2.1:	
Figure 2.2:	Technological and Structural Change and Labor Market Dynamics
Figure 3.1:	The Risk of Becoming Unemployed by Branch (1980 and 1985)
Table 3.1:	The Risk of Becoming Unemployed by Branch (Flow into Unemployment in the Relation to Employees subject to Social Insurance)
Table 4.1:	Correlation Coefficients between Innovation Indicators
Figure 4.1:	Time Delineation for Innovation and the Risk of Becoming Unemployed
Table 5.1:	Regression Analysis of the Risk of Becoming Unemployed in a Combined Cross-Sectional/Time Series Approach Using Various Covariance Models
Table 6.1:	Regression Analysis of the Link between the Age Structure and Innovative Activity, 1982 and 1986
Гable 6.2:	Regression Analysis of the Link between the Relative Flow from Employment into Non-Participation and Retirement together with Innovation between 1982 and 1985

XXII Contents

Table 7.1:	The Change in Employment, Unemployment and the Supply of Labor in 38 Occupational Groups
Figure 7.1:	The Relationship between the Change of Employment and that in Unemployment
Tools - An H	l Effects of the Use of Industrial Robots and CNC-Machine Empirical Input-Output Analysis (Edler/Filip-Köhn/Meyer- äglin/Wessels):
Table 2.1:	The Employment Effects of the Use and Production of Industrial Robots and CNC Machine Tools in Place of Conventional Technology - summarized results of an empirical model calculation 295
Table 2.2:	Demand Effects and Elasticities of Demand with Respect to Sales Prices which would Compensate for the Employment Effects Induced by the Use of Industrial Robots and CNC Machine Tools - summarized results of an empirical model calculation
Table 3.1:	A Comparison of Forecasts of the Diffusion of Industrial Robots in the Federal Republic of Germany
Figure 3.1:	Simulated Stock of Robots (1985, 1990 and 1995) - by application
Figure 3.2:	Simulated Stock of Robots (1985, 1990 and 1995) - by user branch
Figure 3.3:	Change in Total Employment Due to the Diffusion of Industrial Robots
Figure 3.4:	Employment Effects of the Diffusion of Industrial Robots - by component category
Table 3.2:	Changes in Cost Structure due to the Diffusion of Industrial Robots in User Branches Compared with the Reference Scenario - changes in % of the value of output
Figure 3.5:	Employment Effects of the Diffusion of Industrial Robots - with and without additional compensatory effects
Table 3.3:	Employment Effects of the Diffusion of Industrial Robots with Additional Compensatory Effects - Change in per cent of Employment in Baseline Projection 313

Contents	
Comenia	XXIII
	AAIII

TANDEM: Simulations within the Innovation-Growth-Employment-Circuit (Frühstück/Wagner):			
Figure 2.1:	Flow Diagram for Tandem 1		
Table 2.1:	The System of Equations in Tandem 1		
Figure 2.2:	Flow Diagram for Tandem 2		
Table 2.2:	The System of Equations in Tandem 2327		
Table 2.3:	Sectoral Classification of Tandem 1 and 2		
Table 3.1:	The Elasticities of the Innovation Function		
Table 5.1:	Production Function		
Table 6.1:	Makroeconomic Multipliers		
Table 7.1:	The Standard Scenario and Problem-Oriented Scenarios 342		
Table 7.2:	Contrasting Effects		
	for Macro-Economic Development at Different Rates e Activity (Blazejczak):		
Table 3.1:	Effects of Increased and Reduced Innovation 355		