Employment Growth in Manufacturing: Evidence from Developed Countries

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ABSTRACT---- ***The primary purpose of this paper is to provide an evidence on the nature of growth of employment in manufacturing sector of 11 developed countries over the sixty two-year period 1950-2011. An attempt has also been made to explore the reasons for the observed nature of employment growth.***

Keywords—Employment, output, wages, manufacturing

1. INTRODUCTION

The problem of low employment elasticity in manufacturing – that is, the feeling that employment growth has been lagging seriously behind output growth -- has been a serious issue in development economics since the sixties (Morawetz 1974) .In this paper we undertake a systematic analysis of the nature of growth of employment and the determinants of manufacturing employment growth in 11 developed countries.using time series data during 1950-2011.This work is structured in the following way. The materials and methodology used for the empirical analysis are presented in the next section and the empiricalresults are reported in the third section. The summary and conclusions are presented in the final section.

2. MATERIALS AND METHODS

When calculating growth rates of employment and output, the responsive variables were employment and output and the predictor variable was time trend. When estimating the employment determination function, employment was the responsive variable and the output, time trend and wageswere the predictor variables. Employment growth depends on the growth of output, wages and technological progress. When output grows, employment grows so there is a positive correlation. The time trend variable is considered as proxy for capital stock and techniques of production. With the progress of technology, the employment declines so there is a negative correlation. When the wage cost increases the employment declines so there is a negative correlation.Employment also changes in line with the previous year's employment so there is a positive correlation

The main source of data used for this analysis came from Bureau of Labour Statistics, Division of International Comparisons. The main variables included in this analysis are employment, output, wages and time trend.Manufacturing output is represented as the index of output in manufacturing.For most of the economies, output measures are real value added in manufacturing, based on national accounts.Manufacturing employment is represented by the index of total hours in manufacturing and manufacturing wage **i**s represented by the index of hourly compensation in manufacturing which is hourly compensation plus hourly net employment taxes. All the index series are available from 1950 to 2011 in annual form which are based on the base 2002=100. The list of countries selected in this paper include US, Canada, Denmark, France, Germany, Italy, Japan, Netherlands, Norway, Sweden and UK. 11 countries were selected mainly on the basis of availability of data from 1950 to 2011. All the variables except time trend have been transformed into logarithms to make the data and estimation more stable.This paper estimates the annual average growth rates of employment and output using a linear trend model.

$\ln E = \alpha + \beta T + e$ (1);

$$\ln Y = \alpha + \beta T + e \quad (2)$$

Where E stands for employment, Y for Output and T for time Trend.

Hypothesis:

To determine whether the model(1) is adequate

H_0: $The\ regression\ model\ does\ not\ fit\ the\ data$; H_a: $The\ model\ fits\ the\ data$

$\propto = 0.05$; $F_{obs} = \frac{MS_{Regression}}{MS_{Residual}}$; Reject H_0 if p-value < 0.05

To determine the significance of partial regression coefficient of T in models (1) and (2) use the t test

$H_0: \beta = 0\ There\ is\ not\ a\ linear\ relationship;\ \ H_a: \beta \neq 0\ There\ is\ \ a\ linear\ relationship$

$\propto = 0.05$; Reject H_0 ifp-value < 0.05 ;$t_{obs} = \frac{\beta}{SE_\beta}$

where β is the estimated regression coefficient from the analysis and SE_β is the standarderror associated with the estimated regression coefficient β. The final employment determinant model (3) is estimated using the following VARequation.

$$\ln \Delta E = \propto + \sum_{i=0}^{N} \beta_i \ln \Delta E_{-i} + \sum_{i=0}^{N} \beta_j \ln \Delta Y_{-i} + \beta_k \sum_{i=0}^{N} W_{-i} + \beta T + e_t \quad (3)$$

To determine whether the regression model (3)is adequate

$H_0: \beta_i = \beta_j = \beta_k = \beta = 0\ The\ regression\ model\ is\ not\ \ adequate;\ H_a: Not\ all\ \beta_i\ \ equal\ zero$

$\propto = 0.05$; $F_{obs} = \frac{MS_{Regression}}{MS_{Residual}}$; Reject H_0 if p-value< 0.05

To determine the significance of partial regression coefficient, use the t test

$H_0: \beta_1 = 0\ There\ is\ not\ a\ linear\ relationship H_a: \beta_1 \neq 0\ There\ is\ \ a\ linear\ relationship$

$\propto = 0.05$; $t_{obs} = \frac{\beta_i}{SE_{\beta i}}$; Reject H_0 ifp-value < 0.05

Model (3) has been estimated in first log differenes to avoid the issue of autocorrelation.In all of the models, the basic assumptions of residuals like the independence, normality,homoscedasticity, multicollinearity(only in model 3), leverage and existence of outliers have been investigated. The presence of heteroscedasticity is examined with the help of White's test. The assumption of normality is examined with the help of Chi-square test. The presence of leverage has been checked with Cook's distance plot. The presence of outliers have been checked with Box Plot.When the growth rates were estimated from model 1 and 2 , it had clearly shown the presence of autocorrelation confirmed by Durbin-Watson. Then the growth ratesare estimated with Prais-Winsten (GLS-PW) which is a procedure in econometrics, which adjusts a linear model for serial correlation in the error term. So in this paper we estimate the growth rate using GLS-PW.In econometrics, Prais–Winsten estimation is a procedure meant to take care of the serial correlation of type AR(1) in a linear model. It is a modification of Cochrane–Orcutt estimation in the sense that it does not lose the first observation and leads to more efficiency as a result.

3. EMPIRICAL RESULTS

Tables 1 shows the estimated average growth rates of employment and output obtained from GLS-PW. Manufacturing in all selected countries experienced positively significant growth rates in output during 1950-2011. Output grew at an average annual rate of 6.76% in Japan, around 3% each in US, Canada, France, Germany, Netherlands and Sweden; around 4% in Italy, 1.27% in UK, 2% each in Denmark and Norway during 1950-2011. During the same period, employment growth rates in manufacturing was negative in 8countries and 6 of them were significant. Canada is the only country experienced significant positive growth rate (0.20%) of employment in manufacturing during 1950-2011.Output growth rates were positive and significant for all countries during 1950-60 and 1961-70. 10 countries had positive growth rates in output, but significant for 8 in 1971-80 and 9 in 1981-90. Output grew positively in all countries but significant in 9 during 1991-2000. Output grew positively in 6 countries but significant only in 4 and 6 countries had negative growth rates and it was significant for 1 during 2001-11. Manufacturing emplyment grew positively in ten countries during 1950-1960. Emplyment growth rates were negative in six countries during 1961-70, nine countries in 1971-80, eight countries each in 1981-90 and 1991-2000, 11 countries in 2001-11.

Table 2 shows the regression estimates of employment on output, wages and time trend for the period 1950-2011. The employment elasticity of output is positive and has expected sign for all countries. The employment elasticity varied between 0.76 for US to 0.64 for UK. It was 0.63 for Canada, around 0.40 for Denmark, France, Germany,Italy and Norway. It was around 0.33 for Japan,Netherlands and Sweden. Effect of wage growth is negative for all countries except Sweden and UK. The employment elasticity of wages is negative and statistically significant for Denmark, France, Italy, Japan and Netherlands. The negative employment elasticity of wages was 0.49 for Denmark, 0.43 for France, 0.21 for Italy, 0.22 for Japan and 0.18 for Netherlands.The coefficient of technological progress variable T is having an expected negative sign and it is significant for US and Japan.The coefficient of first lag of employment is positive for all except Japan but significant for Canada, France, Germany,Netherlands, Norway, Sweden and UK. The coefficient of first lag of output is positive and statistically significant for Denmark, Italy, Japan, Netherlands and Norway. The coefficient of first lag of wages is negative and significant only for Netherlands and the coefficient has a significant positive sign for Canada and France.

Table 1 Estimated Annual Average Growth Rates of Employment

Countries	50-60	61-70	71-80	81-90	91-00	01-11	51-11
US	0.14	2.07***	0.7	0.55	0.44	-2.98***	-0.24
	(0.35)	(3.26)	(1.2)	(1.99)	(1.95)	(-6.30)	(-0.75)
Canada	0.29	2.42***	0.58	0.83	1.80***	-2.62***	0.20***
	(0.96)	(5.00)	(1.33)	(1.48)	(7.55)	(-5.11)	(5.15)
Denmark	1.22**	-0.75	-3.24***	-0.17	0.01	-3.26***	-1.17***
	(2.7)	(-1.62)	(-8.22)	(-0.26)	(0.07)	(-6.61)	(-4.58)
France	0.1	0.04	-1.25***	-2.08***	-1.77***	-2.45***	-1.21***
	(0.5)	(0.12)	(-10.32)	(-3.99)	(-5.49)	(-14.55)	(-4.74)
Germany	3.26***	-0.84	-1.24***	-0.67	-2.99***	-1.12***	-0.69
	(4.56)	(-1.88)	(-4.56)	(-2.20)	(-4.22)	(-5.33)	(-1.93)
Italy	2.50***	0.85	0.44***	-0.86	-1.14**	-1.47**	0.05
	(21.04)	(2.16)	(6.00)	(-1.41)	(-2.78)	(-2.88)	(0.17)
Japan	6.02***	2.68***	-1.18**	0.87***	-2.73***	-1.75***	0.69
	(30.13)	(12.38)	(-2.79)	(6.37)	(-13.88)	(-3.79)	(1.37)
Netherlands	1.39***	-0.82**	-3.01***	-0.63	-0.77**	-1.58***	-0.95***
	(5.56)	(-2.59)	(-9.93)	(-1.30)	(-2.33)	(-6.50)	(-4.60)
Norway	-0.15	-0.1	-1.66***	-2.77***	0.80	-0.34	-0.93***
	(-0.50)	(-0.34)	(-6.09)	(-5.96)	(1.62)	(-0.52)	(-5.65)
Sweden	NA	-0.77***	-2.02***	0.35	0.86	-1.93***	-0.98***
		(-4.29)	(-5.89)	(2.04)	(1.67)	(-6.91)	(-9.53)
UK	0.90***	5.06***	-1.92***	-0.63	-0.84	-4.05***	-1.79***
	(4.07)	(4.57)	(-8.42)	(-1.45)	(-1.48)	(-20.92)	(-5.23)

Note: t- statistics are in Parenthesis;
***,**,* Statistically significant at 1 and 5 percent respectively

Table 1 (Continues) Estimated Annual Average Growth Rates (%) of Output

Countries	50-60	61-70	71-80	81-90	91-00	01-11	51-11
US	1.98***	5.06***	3.15***	4.06***	4.87***	2.09**	3.23***
	(4.3)	(4.60)	(4.64)	(10.98)	(39.27)	(2.62)	(33.72)
Canada	4.14***	6.25***	3.78***	3.69***	5.39***	-1.49**	3.14***
	(11.77)	(8.50)	(8.58)	(7.02)	(15.03)	(-2.25)	(6.39)
Denmark	4.23***	6.03***	1.88***	1.58	2.70***	-0.86	2.44***
	(4.76)	(27.80)	(5.63)	(2.11)	(8.70)	(-1.50)	(4.88)
France	3.18***	7.01***	3.12***	1.06**	2.22***	-0.01	2.72***
	(10.22)	(36.8)	(10.50)	(2.75)	(5.71)	(-0.02)	(6.40)
Germany	10.97***	5.26***	1.97***	1.85***	0.29	0.74	3.48***
	(17.16)	(10.90)	(7.00)	(6.85)	(0.42)	(0.71)	(4.86)
Italy	7.99***	7.25***	7.32***	2.84***	1.60***	-0.82	4.15***
	(31.00)	(16.44)	(26.11)	(6.34)	(5.66)	(-1.19)	(6.36)
Japan	15.08***	13.25***	3.75***	4.91***	0.45	2.15**	6.76***
	(24.63)	(19.34)	(6.51)	(15.30)	(1.10)	(2.94)	(6.32)
Netherlands	6.61***	6.60***	1.86***	3.32***	2.75***	1.32***	3.48***
	(17.22)	(34.88)	(5.71	(21.77)	(11.86)	(3.11)	(8.18)
Norway	3.64***	4.91***	1.07	-0.16	1.80***	1.92***	2.01***
	(14.90)	(26.80)	(2.2)	(-0.26)	(6.62)	(3.91)	(5.48)
Sweden	3.95***	5.59***	1.03	2.54***	7.99***	2.63	3.45***
	(10.45)	(20.41)	(1.51)	(5.11)	(14.21)	(1.97)	(11.53)
UK	3.00***	3.61***	-0.12	3.14***	1.62***	-0.56	1.27***
	(9.17)	(15.24)	(-0.23)	(10.0)	(11.04)	(-1.37)	(4.46)

Note: t- statistics are in Parenthesis
***,**,* Statistically significant at 1 and 5 percent respectively

Table 2:Regression Estimates of Employment on Output, Wages and Time Trend

	US	Canada	Denmark	France	Germany	Italy
CONST	-0.01(-1.42)	-0.02**(-2.50)	-0.02(-1.23)	0.005(0.47)	0.003(0.17)	-0.03**(-2.44)
ΔE(-1)	0.15(0.94)	0.47***(4.10)	0.08(0.66)	0.33**(2.21)	0.30**(2.33)	0.11(0.90)
ΔY	0.74***(14.88)	0.63***(15.45)	0.44***(5.99)	0.40***(6.00)	0.45***(9.86)	0.42***(7.11)
ΔY(-1)	0.10(0.87)	-0.08(-1.10)	0.38***(4.47)	0.04(0.51)	-0.02(-0.28)	0.22***(3.23)
ΔY(-2)	-0.02(-0.31)			-0.06(-1.01)		
ΔY(-3)				-0.07(-1.10)		
ΔW	-0.001(-0.01)	-0.38(-3.71)	-0.49***(-3.94)	-0.43***(-5.43)	-0.07(-0.65)	-0.21***(-3.12)
ΔW(-1)	-0.01(0.07)	0.29***(2.86)	0.12(0.79)	0.31***(3.25)	-0.16(-1.30)	0.09(1.35)
ΔW(-2)			-0.20(-1.51)	0.06(0.75)	-0.06(-0.55)	
ΔW(-3)			0.43***(3.22)	-0.07(-1.14)		
ΔW(-4)			-0.13(-1.09)			
T	-0.0004**(-2.61)	0.0003(1.86)	0.0001(0.58)	-0.0004(-1.69)	-0.0001(-0.38)	0.0003(1.67)
DW	2.03	1.87	2.00	1.80	1.80	2.08
	0.86	0.86	0.77	0.75	0.80	0.67
F	45.69***	55.36***	17.46***	13.90***	28.44**	17.74***

Note: t- statistics are in Parenthesis
***,** Statistically significant at 1 and 5 percent respectively

Table 2 (Continues):Regression Estimates of Employment on Output, Wages and Time Trend

	Japan	Netherlands	Norway	Sweden	UK
CONST	0.04(2.53)	0.007(0.84)	-0.02(-1.32)	-0.02**(-2.65)	-0.01(-0.77)
ΔE(-1)	-0.21(-1.33)	0.23**(2.10)	0.30***(2.76)	0.23*(1.79)	0.54***(4.69)
ΔY	0.35***(8.96)	0.32***(5.87)	0.39***(4.67)	0.34***(7.36)	0.64***(10.04)
ΔY(-1)	0.18***(2.76)	0.15**(2.53)	0.23**(2.32)	0.08(1.29)	-0.18(-1.84)
ΔY(-2)	0.05(0.82)				-0.03(-0.43)
ΔY(-3)	0.04(0.60)				-0.12(-1.97)
ΔW	-0.22**(-2.46)	-0.18***(-2.74)	-0.10(-0.88)	0.03(0.45)	0.01(0.15)
ΔW(-1)	-0.14(-1.29)	-0.16**(-2.05)	0.02(-0.13)	-0.08(-1.14)	-0.03(-0.51)
ΔW(-2)					
ΔW(-3)					
ΔW(-4)					
T	-0.001***(-3.99)	-0.0003(-1.69)	0.0002(1.16)	-0.00(-0.07)	-0.0001(-0.72)
DW	1.84	2.14	1.78	1.71	1.99
	0.88	0.74	0.58	0.64	0.84
F	29.44***	25.17***	12.01***	15.82***	31.55***

Note: t- statistics are in Parenthesis
***,** Statistically significant at 1 and 5 percent respectively

4. SUMMARY AND CONCLUSION

Manufacturing output has shown positive growth rates, but employment has shown negative growth rates except Canada during 1950-2011. Technological progress had a significant negative impact on employment growth in US and Japan. Employment was also negatively impacted by the growth of wages in countries like Denmark, France, Italy, Japan and Netherlands. Wage cut would be a solution for promoting employment growth in manufacturing in countries like Denmark, France, Italy, Japan and Netherlands. Promoting labour-intensive technology will also help in promoting manufacturing employment in Japan and US.

5. REFERENCES

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