Multinational Companies and Wage Inequality in the Host Country: The Case of Ireland

By

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I. Introduction

The introduction of new technologies in an economy can be expected to have effects on the demand for labour, as firms using a higher level of technology may be more prone to using skilled labour more intensively than unskilled labour. A number of scholars have recently argued that the advent of new technologies has led to a shift in labour demand towards skilled labour which, in turn, has led to an increase in the wage of skilled relative to unskilled workers. In other words, the introduction of new technologies has led to a rise in wage inequality in the respective economy (Katz and Murphy 1992; Lawrence and Slaughter 1993; Berman et al. 1994; Machin et al. 1996).

However, this explanation for an increase in wage inequality is by no means unanimously accepted.[1] A second rationale put forward to explain the increase in wage inequality is the impact of international trade on labour demand. Traditional Heckscher-Ohlin theory of international trade and, more specifically, the factor price equalization theorem (Stolper-Samuelson theorem) suggests that free trade between a developed and a developing country will tend to equalize wages for similar

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[1] See Burtless (1995), Richardson (1995), Johnson (1997), Slaughter (1998) and Wood (1998) for concise reviews and evaluations of the literature on the impact of trade and technological change on wage inequality.

types of labour between these two countries. Assuming, very crudely, that labour in a developing country is equivalent to unskilled labour in a developed country, this implies that unskilled labour in the developed country will have to accept a reduction in wages. This leads to an increase in wage inequality between skilled and unskilled labour in developed countries (Borjas and Ramey 1994; Deardorff and Hakura 1994; Sachs and Shatz 1994; Wood 1994, 1995).

In this paper, we provide a slightly different way of looking at this issue by attempting to explore the impact of multinational companies (MNCs) on wage inequality in the host country. Multinational companies are widely regarded as playing a major role in introducing new technologies in the host country and diffusing it to indigenous firms through technology transfers (Findlay 1978; Das 1987; Wang and Blomström 1992). Recently, Feenstra and Hanson (1997) find in an empirical study for Mexico during the 1980s that the inflow of foreign capital has led to an increase in wage inequality in the country. They argue that multinationals from developed countries outsource production activities to developing countries such as Mexico, thus leading to an increase in the relative demand for skilled labour and a subsequent rise in the relative wage of skilled labour in the developing country.

We suggest that the effect of MNCs on wage inequality be not only confined to outsourcing activities in developing countries. Based on a model by Aghion and Howitt (1998) we argue that MNCs introduce a higher level of technology in the host country, which leads to an increase in the demand for skilled labour and, thus, a change in wage inequality between skilled and unskilled labour.[2]

We conduct an econometric study using data for the Irish manufacturing sector, where foreign multinational companies have played a significant role over the last two decades. Data from the Central Statistics Office (1997) indicate that, in 1995, multinationals accounted for approximately 47 per cent of employment, 77 per cent of net output produced and 83 per cent of total exports in the Irish manufacturing sector. The importance of MNCs for the Irish economy has been well documented and analyzed in the recent literature (Foley and McAleese 1991; Barry and Bradley 1997; Ruane and Görg 1997). Our results indicate that there is an inverted-U shape relationship between wage in-

[2] Markusen and Venables (1997), in a theoretical framework, also argue that multinational companies have a role to play in explaining the rising wage gap between skilled and unskilled workers.

equality and the presence of multinationals in Ireland.[3] With increasing presence of MNCs, inequality first increases, reaches a maximum and decreases eventually.

The remainder of the paper is structured as follows. In Section II, we briefly discuss the theoretical background for our analysis, which is based on a model proposed by Aghion and Howitt (1998). Section III introduces the econometric model, discusses the data used for our analysis and presents some descriptive data pertaining to wage inequality and multinational companies in Ireland. Section IV presents our econometric results, while Section V draws some conclusions and highlights the need for further research.

II. A Model of Multinationals and Wage Inequality

The model which links the presence of multinational companies and wage inequality in the host country is based on the endogenous growth model developed by Aghion and Howitt (1998: Chapter 8). They discuss the effects of social learning on economic growth, and the effect of differences in workers' skill levels on aggregate output and wages in the economy. We employ their model here, re-interpreting it in terms of the effect of multinational companies on the availability of new technologies in the economy. Essentially, we view multinationals as vehicles for introducing new technologies in the host economy and as "role models" for indigenous firms; indigenous firms learn by imitating the more advanced production technologies used in multinationals.

As in Aghion and Howitt (1998), we assume the following production structure

$$Y = \left\{ \int_0^1 A_i^{\alpha} x_i^{\alpha} \, \mathrm{d}i \right\}^{1/\alpha}, \quad 0 \leq \alpha \leq 1, \tag{1}$$

where aggregate output Y is produced using intermediate inputs x in each sector i. Intermediate inputs x are produced using labour as the on-

[3] Note that we concentrate on the issue of wage inequality and do not analyze the demand for labour or the determinants of wage rates in manufacturing per se. Kearney (1997) describes aggregate changes in labour demand in Irish manufacturing and Kearney (1998) estimates long-run demand functions for skilled and unskilled labour, and wage earners and salaried earners, respectively. Also, we are only concerned with wage inequality, i.e., inequality amongst different wage groups unlike Lane (1998), who discusses changes in the functional distribution, i.e., the evolution of wage and profit shares in Ireland.

ly factor of production. The level of output depends crucially on the production technology, which is represented by the technology parameter A. This parameter is equal to 1 if the old technology is used and $A > 1$ if the new technology is used, i.e., the technology parameter A is raised by a constant factor γ in the case of the new technology. Initially, we assume that the economy uses only the old technology, and new technologies are introduced into the economy solely through multinational companies.[4]

Aghion and Howitt show that the introduction of a new technology from MNCs leads to two stages of development. In the first stage, indigenous firms need to acquire a template for experimenting with the new technology as they are unfamiliar with it. While doing so they still produce output using the old technology, but they also invest in R&D in the attempt to discover such a template, particularly through the imitation of firms that already use the new technology. Initially, the firms which are imitated are multinational companies present in the economy; they act as "role models" because they have access to a higher standard of technology than indigenous firms. In stage 2, firms use the newly acquired template to produce the final output through the application of the new technology and, by the end of the adjustment process, all firms have made the jump into stage 2 and are using the new technology for production purposes.[5]

One assumption made by Aghion and Howitt is that producing with the old technology requires only unskilled labour. Firms in stage 1 need a fraction of skilled labour to carry out the research necessary for the discovery of the template, while unskilled workers still produce output using the old technology. Firms in stage 2 which successfully implement the new technology require only skilled labour for production with the new technology.

The implications of the model with respect to the labour market are as follows: at the beginning of stage 1, demand for skilled labour is very low, and skilled and unskilled labour are paid the same wage. Later on, however, demand for skilled labour steeply increases, thus leading to labour-market segmentation in which skilled labour is paid a higher

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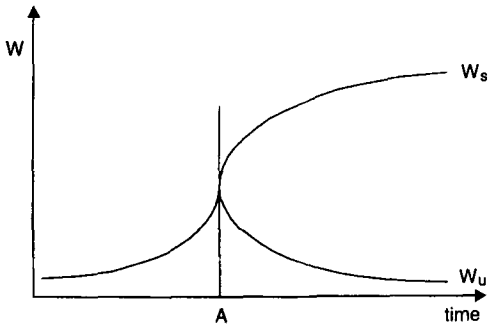
[4] The fact that multinational companies have access to a superior level of technology reflects the existence of ownership advantages or firm-specific assets which allow MNCs to compete successfully abroad (see Caves 1996 and Dunning 1988).

[5] The speed of adjustment depends, among other factors, upon the probability that a firm learns through imitation, the probability that a firm makes a discovery of a template on its own and the number of MNCs in the economy.

Figure 1 – *Development of Wages*



Source: Aghion and Howitt (1998: 261).

wage. Aghion and Howitt (1998) show that, in the segmented labour market, the wage rates are

$$w_s = \alpha \gamma^{\alpha} \left(\frac{n_2 Y}{L_s - n_1 s} \right)^{1-\alpha} \qquad \text{for skilled workers} \qquad (2)$$

and

$$w_u = \alpha \left(\frac{(1-n_2) Y}{L - L_s} \right)^{1-\alpha} \qquad \text{for unskilled workers,} \qquad (3)$$

where w_s and w_u denote the wage rates for skilled and unskilled workers, respectively, Y is aggregate final output, n_1 and n_2 are the number of firms in stage 1 and stage 2, respectively, s is the fraction of skilled labour used by firms in stage 1, L_s is the number of skilled workers and L is the total number of workers in the economy.[6] As more and more firms move into stages 1 and 2, demand for unskilled labour falls. Eventually, when all firms move into stage 2, i.e., $n_2 = 1$, the wage rate $w_u = 0$ and there will be only one wage rate w_s prevailing in the economy. The evolution of wages is shown in Figure 1. There is a point in time (A) at which, due to the increased demand for skilled labour, the labour market becomes segmented; the wage for skilled workers increases and the wage for unskilled workers falls towards zero.

[6] Note that $w_u < w_s$ and that w_u tends towards zero when L_s increases.

What are the implications of such a development for wage inequality in the economy? Arguably, the described adjustment process leads to an inverted-U shape development of wage inequality with respect to the presence of multinationals. In the early stages of the presence of multinationals, wage inequality increases because indigenous firms learn by imitating multinationals, move into stages 1 and 2, and demand more skilled labour. The higher the number of multinationals present in the economy, the faster the speed of adjustment. Following an adjustment period, wage inequality decreases with more MNCs present in the economy, since all firms move into stages 1 and 2 and demand for unskilled labour falls towards zero. Eventually, only skilled labour will be employed when all firms are in stage 2.[7] Therefore we need to distinguish between the pattern of inequality, which is the result of the implicit disappearance of the unskilled workers, and the simple comparison between wage levels of skilled and unskilled labour (the latter is supposed to keep increasing over time).

III. Methodology and Data

We attempt to establish whether there exists any empirical support for the hypothesis of an inverted-U relationship between wage inequality and the presence of MNCs by examining data from 1979 to 1995 for the manufacturing sector in Ireland.[8] Multinationals can be expected to be vehicles for introducing new technologies in the country, not least due to the fact that multinationals in Ireland are particularly active in the high-tech manufacturing sectors electronics and pharmaceuticals (Barry and Bradley 1997; Ruane and Görg 1997).

Employment in multinational companies in Irish manufacturing is calculated from data available from the annual *Forfás Employment Survey* (Forfás 1996). The survey includes employment data on virtually all existing manufacturing firms in Ireland, distinguishing between Irish and

[7] This pattern is similar to the Kuznets curve relating income inequality to the level of GDP (Kuznets 1955). Kuznets considered a dual economy with two income groups, viz., owners of capital and workers, and argued that GDP growth led to first rising and then falling inequality between these two groups.

[8] The choice of 1979 as a starting point for our analysis is due to data constraints; 1979 is the first year in which the wage data were available. Nevertheless, while there were MNCs in Ireland before 1979, the period analyzed may be considered the most relevant for our study as multinationals in the early 1970s and before were predominantly UK-owned firms in traditional sectors. Only in the late 1970s/early 1980s did this pattern change and the most important group of MNCs are, at present, US-owned companies in high-tech industries (Ruane and Görg 1997).

Table 1 – *Employment in MNCs as Percentage of Employment Per Sector*

Sector	1979	1983	1987	1989	1991	1993	1994	1995
Food, drink, tobacco	27.8	28.7	29.8	29.8	28.2	26.9	26.6	25.7
Textiles & clothing	37.7	41.3	42.5	43.0	43.7	42.8	43.4	43.1
Timber & furniture	4.5	4.6	5.3	5.1	4.1	4.3	4.3	4.6
Paper & printing	12.7	12.6	12.8	13.0	13.4	12.6	13.1	13.5
Chemicals	71.3	74.3	76.6	77.0	78.0	78.9	78.8	79.1
Non-metallic minerals	24.1	25.6	24.1	24.5	24.8	24.0	24.2	23.1
Metals & engineering	53.9	57.3	59.3	60.5	60.8	61.2	61.9	62.3
Miscellaneous	48.6	42.9	39.7	41.2	38.2	37.1	37.4	36.9
Total	37.7	40.0	41.7	43.1	43.4	43.6	44.3	44.9

Source: Own estimates derived from *Forfás Employment Survey* data.

foreign-owned firms.[9] Table 1 shows the development of the share of employment in foreign-owned multinationals by sector over the period 1979–1995. It is apparent that the total employment share has increased constantly over that period, although there are differences across sectors.

The theory described above suggests that, within each sector, MNCs and indigenous firms would cohabit, the former bringing new technologies (and increasing demand for skilled labour), the latter using old technologies (using unskilled labour), imitating and eventually moving to new technologies and increasing demand for skilled labour also. As pointed out in Section II, the theory would lead us to expect an inverted-U shape when wage inequality *within* the same sector is measured.[10]

The trend of within-sector inequality could easily be measured were the distribution of wages in each sector available. Unfortunately, we can only proxy inequality through measuring a wage gap, *viz.*, the gap between white-collar and blue-collar workers using average wages of white-collar workers (w_w) and blue-collar workers (w_b) in each sector:

$$INEQ_{i,t} = [(w_w - w_b)/w_w]_{i,t}. \tag{4}$$

The *Census of Industrial Production* includes wages for industrial workers and administrative & technical staff by sector which, following Kear-

[9] A firm is classified as being foreign-owned if 50 per cent or more of its capital is owned by foreign shareholders (Forfás 1996).

[10] Another interesting development of the Aghion-Howitt model would link the presence of multinational companies to the trend of wage inequality *between* sectors. For a description of this issue and a discussion of empirical findings for Ireland we refer to a previous version of this paper (Figini and Görg 1998).

ney (1997, 1998), we take as proxies for blue-collar and white-collar workers, respectively. While this distinction between "production" and "non-production" workers does not completely overlap with the distinction between "skilled" and "unskilled" workers, several recent studies show that there is a very high correlation between them (Berman et al. 1994; Machin et al. 1996).

Furthermore, in a dynamic context, the disaggregation between white-collar and blue-collar workers allows us to represent the process of skill improvement through the use of new technology described above, while the simple measurement of wage gaps between skilled and unskilled workers would lead to a monotonic increase in inequality as wages for unskilled labour tend towards zero.

Our rationale is the following: we assume that in the first stage of the presence of multinationals, new technologies improve the skills of white-collar workers mainly, thus increasing their productivity and wage. Blue-collar workers remain initially unskilled, while white-collar workers become skilled. However, this changes over time, and in stage two blue-collar workers eventually become more skilled in order to be able to work with the new technology. The acquisition of skills should be thought of as a process of "learning-by-doing" rather than formal (third-level) education. Therefore, we postulate that the group of blue-collar workers evolves over time from being "unskilled" to being "skilled". This implies that, initially, wage inequality between unskilled blue-collar and skilled white-collar workers increases but, as blue-collar workers become more skilled, the wage gap reduces and inequality, as measured in (4), gradually decreases.

This assumption can be partially supported by the theory. MNCs investing in a sector first require skilled labour that is mainly used in white-collar jobs. Due to a better educated workforce and new technologies, we expect an increase in skills and productivity also for blue-collar industrial workers. Hence, relative wage changes for white-collar and blue-collar workers are the complex result of interactions between changes in the relative productivity of the two categories of workers, skill improvement and relative changes in the demand and supply of skilled and unskilled labour.

The *Census of Industrial Production* also includes a third category of workers, namely clerical workers which, as Kearney (1997) shows, is the most dynamic category. She shows that clerical employment has undergone considerable structural changes, accounting for 9 per cent of total employment and 8 per cent of the wage share in 1979, compared to 11 per cent and 12 per cent in 1989, respectively. Kearney argues that

the introduction of computer technologies has changed the skill-intensity of clerical workers, from being more akin to unskilled labour to being more similar to skilled labour.[11] This observation provides also empirical support for our hypothesis on the dynamics of change in skill levels. It can be argued that the process of *skill improvement* validated by the analysis of wages and numbers of clerical workers above, may also have taken place in the case of industrial workers.

The data in Table 2 show that over the period 1979–1995 the ratio of white-collar to blue-collar workers in total manufacturing has increased, which may illustrate a shift towards more skilled labour in Irish manufacturing industries. The figures also indicate that the size of the ratio differs considerably across manufacturing sectors.[12] Table 3 shows that the wage gap between white-collar and blue-collar workers has increased from around 43 per cent to 47 per cent between 1979 and 1995. Again, this masks different developments across sectors; for example, the wage gap in the Office Machinery sector, which includes the high-tech computer manufacturers, decreased while the gap in the Food, Drink, Tobacco sector increased over the period.

To analyze the development of the wage gap in more detail, we carry out a cross-section time-series analysis of manufacturing sectors. We estimate the econometric model

$$INEQ_{i,t} = b_0 + b_1 FOREIGN_{i,t} + b_2 FORSQ_{i,t} + b_3 IMPORT_{t-1} + b_4 EDU_{t-3} + e_{i,t}, \quad (5)$$

where $INEQ_{i,t}$ is measured as the wage gap between blue-collar and white-collar workers in each sector as in (4). $FOREIGN_{i,t}$ represents the share of employment in foreign-owned firms in sector i over total employment in the sector at time t, calculated from *Forfás Employment Survey* data. $FORSQ_{i,t}$ is the square of $FOREIGN_{i,t}$ to allow for the inverted-U shape. To be in line with the inverted-U relationship between MNCs and inequality, we expect the signs of the estimated coefficients to be positive for *FOREIGN* and negative for *FORSQ*.

As pointed out above, imports from unskilled-labour-intensive countries may also be expected to affect wage inequality. According to Heckscher-Ohlin theory, these imports impact upon relative wages for

[11] Given this ambiguity, we do not include this group in our analysis. However, earlier results (available from the authors upon request) indicate that the inclusion of clerical workers as skilled labour does not change the results significantly.

[12] The 17 manufacturing sectors correspond with the NACE Rev. 1 classification. This differs from the classification used by Forfás for the employment data presented in Table 1.

Table 2 – *Ratio White-Collar to Blue-Collar Workers*

	1979	1983	1987	1991	1993	1994	1995
Total	0.128	0.143	0.164	0.176	0.186	0.184	0.181
Food, drink, tobacco	0.146	0.154	0.153	0.165	0.162	0.163	0.172
Textiles	0.102	0.107	0.106	0.114	0.121	0.114	0.113
Wearing apparel	0.064	0.061	0.069	0.055	0.058	0.050	0.054
Leather products	0.065	0.067	0.097	0.092	0.085	0.083	0.078
Wood products	0.096	0.117	0.121	0.117	0.134	0.121	0.112
Paper products	0.119	0.122	0.157	0.169	0.174	0.174	0.169
Publishing, printing	0.224	0.212	0.233	0.297	0.320	0.359	0.361
Chemicals	0.266	0.273	0.326	0.374	0.369	0.425	0.393
Rubber, plastic	0.118	0.138	0.127	0.129	0.120	0.116	0.125
Non-metallic minerals	0.103	0.121	0.107	0.154	0.134	0.147	0.140
Metals	0.122	0.140	0.130	0.143	0.141	0.147	0.146
Machinery	0.125	0.146	0.134	0.141	0.143	0.139	0.144
Office machinery	0.232	0.308	0.335	0.424	0.382	0.260	0.200
Electrical equipment	0.135	0.150	0.198	0.194	0.210	0.207	0.214
Motor vehicles	0.089	0.084	0.093	0.084	0.088	0.088	0.078
Other transport equipment	0.064	0.082	0.072	0.121	0.150	0.198	0.147
Miscellaneous	0.088	0.109	0.099	0.153	0.155	0.148	0.132

Source: Own estimates derived from *Census of Industrial Production* data.

Table 3 – *Wage Gap between White-Collar and Blue-Collar Workers*

	1979	1983	1987	1991	1993	1994	1995
Total	0.433	0.425	0.439	0.462	0.473	0.473	0.467
Food, drink, tobacco	0.396	0.342	0.418	0.473	0.510	0.520	0.495
Textiles	0.451	0.415	0.454	0.434	0.455	0.456	0.455
Wearing apparel	0.565	0.554	0.540	0.565	0.564	0.576	0.592
Leather products	0.563	0.541	0.478	0.500	0.379	0.490	0.504
Wood products	0.412	0.423	0.385	0.403	0.378	0.437	0.464
Paper products	0.364	0.426	0.370	0.324	0.394	0.414	0.383
Publishing, printing	0.375	0.336	0.305	0.288	0.308	0.297	0.361
Chemicals	0.317	0.339	0.284	0.365	0.329	0.318	0.343
Rubber, plastic	0.434	0.425	0.460	0.418	0.447	0.469	0.481
Non-metallic minerals	0.398	0.396	0.419	0.452	0.383	0.437	0.434
Metals	0.370	0.362	0.325	0.421	0.430	0.424	0.421
Machinery	0.352	0.399	0.429	0.462	0.461	0.448	0.453
Office machinery	0.575	0.468	0.516	0.522	0.543	0.539	0.391
Electrical equipment	0.469	0.507	0.485	0.482	0.475	0.448	0.477
Motor vehicles	0.364	0.410	0.298	0.345	0.383	0.352	0.393
Other transport equipment	0.407	0.324	0.455	0.220	0.389	0.393	0.367
Miscellaneous	0.605	0.606	0.539	0.499	0.547	0.549	0.571

Source: Own estimates derived from *Census of Industrial Production* data.

unskilled labour by reducing the relative price of (unskilled-labour-intensive) import-competing goods (Sachs and Shatz 1994). To capture this effect properly we would, therefore, need to include the relative price of unskilled-labour-intensive goods in (5). However, as Sachs and Shatz (1994: 35) admit, "[d]ata on trade prices are notoriously problematic, since there are great difficulties in controlling for quality, product mix, and effective market prices".

Since such detailed price data were not available to us for Ireland we include the total value of imports rather than prices, as in Anderton and Brenton (1998).[13] Hence, $IMPORT_{t-1}$ is measured as the value of total imports from developing countries (defined as imports from countries other than EU, EFTA, NAFTA, APEC, or other OECD countries) as a percentage of GDP, for which we would expect a positive sign in the estimation. The import data are taken from the *Trade Statistics* published by the Central Statistics Office while the GDP data are those published by Eurostat.

Also, we include an education variable in the empirical model to control for changes in the supply of skilled labour. EDU_{t-3} comprises the enrolment ratio in third-level education (training of technicians and graduates) in time $t-3$. We decide to use a three-year lag as changes in labour supply due to education are arguably a medium and long-run phenomenon that may not be fully captured using shorter lags.[14] It can be expected that, the higher the enrolment ratio in third-level education, the higher the supply of skilled labour. This, in turn, should reduce wage inequality by increasing the supply of skilled labour and decreasing the supply of unskilled labour. Therefore, the expected sign of EDU_{t-3} is negative. The variable is constructed as the ratio of the number of third-level students as a percentage of the total population, data for which are extracted from various issues of the *UN Statistical Yearbook*. Table 4 shows some summary statistics for the two control variables.[15]

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[13] Katz and Murphy (1992) and Borjas et al. (1992) also include data for trade volumes rather than prices in their analyses of wage inequality in the United States. However, they do not relate their models to the Stolper-Samuelson theorem.

[14] We also experimented using shorter (one and two year) and longer (four and five year) lags, but this did not change the results of the estimation substantially.

[15] In a previous version we also included GDP growth in the regression to control for changes in the relative demand for skilled labour (Figini and Görg 1998). However, as an anonymous referee pointed out, the *FOREIGN* variable itself should capture both the direct effect on relative labour demand by the MNCs themselves and the indirect effect that results from labour demand by imitating indigenous firms. The GDP growth variable should therefore be superfluous in the regression; the finding of an insignificant coefficient supports this reasoning.

Table 4 – *Summary Statistics for Imports and Employment Data*

	Mean	Standard deviation	Minimum	Maximum
Imports	0.0257	0.0090	0.0157	0.0425
Education	20.85	4.71	14.26	30.54

Source: Own estimates derived from various sources.

IV. Econometric Results

Wage inequality within each sector, measured as the percentage gap between the wage of administrative & technical workers and the wage paid to industrial workers, is expected to increase in the early stages of development and to diminish thereafter, due to the increase in productivity and the wider use of skilled labour among industrial workers. Our proposition is that MNCs introduce new technologies into each sector, thus demanding more highly skilled and productive labour. To examine this issue we use data for 17 manufacturing sectors (NACE two-digit) pooled over the period 1979–1995.

Table 5 presents the results for the pooled regression. In Column 1, we report the results for our initial pooled regression assuming constant coefficients for all sectors. The estimated coefficients support the expectation of an inverted-U shape, the sign of the coefficient of the variable *FOREIGN* is positive, while the coefficient of *FORSQ* is negative. This indicates that, as suggested above, an increase in the share of MNCs leads initially to an increase in wage inequality between white-collar and blue-collar workers. Inequality, however, reaches a maximum after which any further increase in the presence of multinationals leads to a decline in wage inequality within each sector.[16] This result differs from Blonigen and Slaughter (1999), who do not find a significant effect of inward foreign direct investment (FDI) on wage inequality in the United States. Arguably, however, the United States and Ireland have very different characteristics as host countries. In particular, related to our hypothesis, we would not expect that MNCs are a major source for introducing new technologies in the United States, while we expect this to be the case for Ireland.

[16] This maximum can be expected to differ across sectors. It may, therefore, be misleading to calculate a maximum point using the reported results and infer that this will be a maximum in each sector.

Table 5 – *Panel Data Analysis*

	(1)	(2)	(3)	(4)
FOREIGN	0.7004	0.6504	0.6939	0.4852
	[6.169]***	[4.408]***	[2.519]**	[0.426]
FORSQ	–0.8895	–0.8279	–0.8844	–0.7036
	[–6.318]***	[–5.108]***	[–2.627]***	[–0.603]
IMPORTS	1.7480	0.1244	1.7471	1.7315
	[1.424]	[0.146]	[1.465]	[1.407]
EDU	0.0044	0.0033	0.0044	0.0043
	[2.017]**	[2.449]**	[2.412]**	[2.302]**
Constant	0.1884	0.2594	0.1901	0.2409
	[2.394]**	[4.621]***	[2.310]**	[0.930]
Sectors/periods	17/15	17/15	17/15	17/15
Observations	255	255	255	255
χ^2 (4)	43.48	39.94	11.97	
F (4, 234)				1.46
R^2			0.15	0.12

Note: z-statistics in brackets; column 1: cross-sectional time-series GLS regression; column 2: cross-sectional time-series GLS regression with heteroskedastic cross-section and autocorrelated (AR1) time-series; column 3: random effects estimation; column 4: fixed effects estimation. – ***=significant at 1 per cent, ** at 5 per cent, * at 10 per cent level.

Inspection of the other variables in the estimations shows that the coefficient of the import variable has a positive but statistically insignificant sign, suggesting that the volume of imports from developing countries does not seem to have a (statistically significant) effect on wage inequality. This result appears to be in line with papers such as Katz and Murphy (1992), Lawrence and Slaughter (1993), and Machin et al. (1996), which do not find any substantial evidence of imports affecting wage inequality in the United States. However, the estimated coefficient has a positive sign, which may give weak support to our expectation that imports do have positive effects on wage inequality, a result found by Haskel and Slaughter (1999) and Anderton and Brenton (1998).[17]

Surprisingly, we find a positive and statistically significant coefficient also for the education variable, suggesting that an increase in the

[17] In alternative regressions run by using the education variable lagged for one or two years, we also obtain positive and statistically significant coefficients for the import variable, giving further evidence to the expectation that imports from developing countries increase wage inequality.

ratio of third-level students to total population increases wage inequality. As pointed out above, our expectation was to find a negative relationship between third-level education and inequality, as a higher enrolment ratio leads to an increase in the supply of skilled labour. A possible explanation for this result could be an endogeneity problem, as increases in wage inequality may be expected to lead to higher enrolment in third-level education.[18] Furthermore, the result could be due to the effect of education on the influx of multinational companies into the host economy. It is frequently asserted (though, to the best of our knowledge, there does not seem to be any "hard" empirical evidence) that one of Ireland's attractions to foreign multinationals is its well-educated labour force (for example, McAleese 1998). Education, thus, can be expected to increase the influx of multinationals, which may, in turn, increase wage inequality. Another issue involved is the role played by migration flows in the determination of the labour force composition in Ireland. Data from the Central Statistics Office show that net migration, while being highly negative in the 1980s and early-1990s, has become positive since 1996. This can be expected to have implications for the extent and skill composition of labour supply in Ireland. However, since data on the skill composition of migrants are not available, we cannot predict any significant impact and, for this reason, we decided not to include migration in our empirical analysis. The result of a positive effect of education on wage inequality clearly deserves more detailed further research.

When combining time-series and cross-sectional data, and assuming constant coefficients over sectors, it appears reasonable to assume that the error terms are heteroskedastic in the cross-sectional observations, while they are autoregressive in the time-series observations. Column 2 of Table 5 presents the results for the estimation of (5) under these assumptions (first-order autoregression) as suggested by Kmenta (1986). The results turn out to be broadly the same as in Column 1, as regards signs and significance of the coefficients.

In another step, instead of imposing constant coefficients over the sectors, we allow the intercept term to differ across sectors, capturing sector-specific time-invariant effects. Such a model can be estimated using fixed effects (FE) or random effects (RE) techniques (Baltagi 1995). In the case of the former, the sector-specific effect is assumed to be an estimable fixed parameter, whereas the latter specification assumes that the effect be a random variable.

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[18] We are grateful to an anonymous referee for pointing this out to us.

We test for the existence of sector-specific effects, i.e., whether the assumption of a sector-specific effect is more appropriate than a mere pooling of data, for both the RE and FE specifications. In the case of RE, a Breusch and Pagan (1980) Lagrange multiplier test yields a χ^2 value of 172.53, which allows us to reject the null hypothesis of zero random effects. For the FE specification, an F-test for the significance of sector-specific effects (Baltagi 1995) produces a value of 8.12, which exceeds the critical value of F(16,234). We can, thus, conclude that the assumption of sector-specific effects is appropriate.

The choice between the RE and FE technique for the estimation of the sector-specific effects on purely *a priori* grounds is ambiguous, as argued by Maddala (1993). We, therefore, performed a Hausman (1978) test for the choice between the two techniques. The test produces a χ^2 value of 0.04, which does not allow us to reject the null hypothesis of no correlation between the sector-specific effects and other independent variables. This result suggests the use of the RE rather than the FE technique for the estimation; the RE estimation is the preferred specification in Table 5. We, nevertheless, include the estimation results for the FE technique for completeness in the presentation of results in Table 5, Column 4.[19]

Examining the results for the RE specification in Column 3, we observe that they are very similar to the pooled regression results reported in Columns 1 and 2 in their signs, magnitudes and significance levels. In particular, the coefficients of *FOREIGN* and *FORSQ* are comparable to the previous ones. This gives further support to our expectation of an inverted-U relationship between the presence of multinationals and wage inequality in the Irish economy.[20]

V. Discussion and Conclusions

In this paper, we present an econometric analysis of *within sector* wage inequality in Ireland. Based on a model of the impact of new technol-

[19] In the FE estimation, the coefficients for *FOREIGN* and *FORSQ* are statistically insignificant. This may be due to multicollinearity amongst some of the independent variables as pointed out by Baltagi (1995); the inclusion of the dummy variables for sectors may exacerbate this problem in the estimation. Also, note that the overall regression is insignificant as indicated by the F-test.

[20] In alternative regressions, we left out the *FORSQ* term using otherwise estimation procedures identical to the ones used in Table 5. The overall insignificance of all these regressions indicates that the inclusion of the squared term is vital for the estimations. The results are not reported here but can be obtained from the authors upon request.

ogies on wage inequality developed by Aghion and Howitt (1998), we argue that the influx of multinational companies into a host country leads to first increasing and then decreasing wage inequality between white-collar and blue-collar workers within each sector.

In the econometric analysis we use pooled data for wage gaps between industrial workers (our proxy for unskilled workers) and administrative & technical staff (our proxy for skilled workers) *within* the same manufacturing sector. Our empirical results for the Irish manufacturing sector between 1979 and 1995 suggest that the presence of MNCs has the effect of first increasing, and then decreasing, wage gaps between the two groups. This is due to the introduction of new technologies through MNCs, which increases the demand for skilled labour, leading to rising wage inequality between skilled and unskilled workers. Over time, indigenous firms learn the new technology by imitating MNCs, and previously unskilled workers become skilled through working with the new technology. This, subsequently, leads to a decrease in wage inequality.

Our findings are in line with recent studies analyzing the demand for labour, such as Boyle and McCormack (1998), Machin et al. (1996) and Kearney (1997, 1998). These empirical studies for a number of OECD countries and Ireland respectively find, *inter alia*, that labour is becoming more skill-intensive over time and that technological progress is biased against unskilled labour. According to the model presented herein, this is the development one would expect in an economy which is subject to the influx of new technologies.

The paper leaves a number of issues to be addressed in further research. For example, we would, ideally, need more precise data on the distribution of wages in each sector, and the ratio of skilled to unskilled workers in MNCs and indigenous companies to further validate our results. Also, we need to investigate further the role played by education and migration in explaining inequality, as our results suggest a positive relationship between inequality and education – a result that appears counterintuitive at first sight.

Furthermore, a comparison of our results with similar studies in other countries experiencing a consistent influx of foreign direct investment would be useful. Feenstra and Hanson (1997) in a recent paper find that FDI in Mexico seems to have a positive effect on the demand for skilled labour, while Blonigen and Slaughter (1999) do not find a significant effect of MNCs on shifts in labour demand in the United States. This may suggest that MNCs only affect labour demand if they introduce relatively advanced technologies, which may not be the case in the United States. However, to conclude on how MNCs impact on a

host country's labour demand and wage inequality, more evidence would be needed.

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Abstract: Multinational Companies and Wage Inequality in the Host Country: The Case of Ireland. – In this paper, the authors analyze the impact of multinational companies on wage inequality in a host country. Based on a model, in which the introduction of new technologies leads to increases in the demand for skilled labour and, therefore, to rising wage inequality, they econometrically study the Irish manufacturing sector between 1979 and 1995. They examine inequality between wages for skilled and unskilled labour within the same manufacturing sector. Their results indicate that there is an inverted-U relationship between wage inequality and multinationals, i.e., with the increasing presence of multinationals, wage inequality first increases, reaches a maximum, and decreases eventually. JEL no. D63, F23, J31

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Zusammenfassung: Multinationale Unternehmen und Lohnungleichheit im Gastland: Der Fall Irland. – Die Verfasser analysieren die Auswirkungen multinationaler Unternehmen auf die Lohnungleichheit im Gastland. Auf der Grundlage eines Modells, in dem die Einführung neuer Technologien die Nachfrage nach qualifizierten Arbeitkräften verstärkt und damit die Ungleichheit unter den Löhnen erhöht, analysieren sie ökonometrisch den gewerblichen Sektor Irlands zwischen 1979 und 1995. Sie untersuchen die Ungleicheit der Löhne von gelernten und von ungelernten Arbeitskräften im gleichen Produktionszweig. Ihre Ergebnisse zeigen, daß es eine umgekehrte U-förmige Beziehung zwischen Lohnungleichheit und Multis gibt, d.h., mit zunehmender Anwesenheit von Multis steigt die Lohnungleichheit zunächst an, erreicht dann ein Maximum und geht schließlich zurück.