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

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Abstract

In this paper, we analyse the effects of multinational companies on wage inequality in the host country, studying the case of the Irish economy. Based on a model developed by Aghion and Howitt (1998), in which the introduction of new technologies leads to increasing demand for skilled labour and, therefore, to rising inequality, we conduct an econometric study using data for the Irish manufacturing sector between 1979 and 1995. We examine inequality between wages for skilled and unskilled labour *within the same manufacturing sector*. Our results indicate that there is an inverted-U relationship between wage inequality and the presence of multinationals, i.e., with increasing presence of multinationals, wage inequality first increases, reaches a maximum and decreases eventually, *ceteris paribus*.

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I INTRODUCTION

The shift in demand away from unskilled and towards skilled labour appears to be widely accepted as a cause for the increase in wage inequality across developed countries (Atkinson, 1997). This process raises wages for skilled labour more than wages for unskilled labour, thus leading to a widening gap between these two groups. Various explanations for this shift have been presented in the literature, which focuses particularly on international trade and technological change as reasons for the observed development (Burtless, 1995; Richardson, 1995; Johnson, 1997).

The increase in North-South trade, i.e., the exchange of goods between developed and developing countries represents one possible link between trade and wage inequality (Wood, 1994; Borjas and Ramey, 1994). Developing countries export goods which are intensive in unskilled labour to developed countries, which leads to a decline of the price of imports and import-competing goods in developed countries. In turn, this results in a decline of wages for unskilled labour in import-competing industries. This process, therefore, leads to a rise in wage inequality in developed countries.

Another strand of literature stresses the impact of the introduction of new technologies, which require skilled labour, on wage inequality (Berman *et al.*, 1994; Machin *et al.*, 1996). Technological change raises the wage rate via increases in the demand for skilled labour, while wages for unskilled labour fall as a consequence of a decrease in the demand for unskilled labour, thus leading to a rise in wage inequality.

Not least in small open economies, the technology- and trade-effects are likely to go hand in hand: free trade with developed countries will lead to the introduction of new technologies in the economy, which, in turn, may lead to increasing demand for skilled labour relative to unskilled labour. However, trade is not the only channel through which new technologies can be introduced externally into an economy. *Inter alia*, foreign direct investment and multinational companies (MNCs) are also seen as a major source for introducing technological change in host countries through technology transfers to indigenous firms (Wang and Blomström, 1992).

In this paper, we assume that multinationals play a major role in introducing new technologies and we study the subsequent effect on wage inequality in the host country, using Ireland as a case study.[1] We conduct an econometric study using data for the Irish manufacturing sector, where multinational companies have played a very significant role in terms of employment over the last two decades (Barry and Bradley, 1997; Ruane and Görg, 1997). Our results indicate that there is an inverted-U shape relationship between wage inequality and the presence of multinationals. 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 2, we present a model formalising the effects of MNCs on wage inequality, which follows closely a model proposed by Aghion and Howitt (1998). Section 3 introduces the econometric model, discusses the data used for our analysis and presents some descriptive data pertaining to wage inequality and multinational

[1] Note that we concentrate on the issue of wage inequality and do not analyse 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) and Boyle and Sloane (1982) estimate 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.

companies in Ireland. Section 4 presents our econometric results while Section 5 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 present 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

$$Y = \left\{ \int_0^1 A_i^a x_i^a \, di \right\}^{1/a}, \quad 0 \le a \le 1 \tag{1}$$

where aggregate output *Y* is produced using intermediate inputs *x* in each sector *i*. Intermediate inputs *x* are produced using labour as the only factor of production. The level of output depends crucially on the production technology, which is represented by the technology parameter *A*. *A* is equal to 1 if the old technology is used and $A = g > 1$ if the new technology is used, i.e., the technology parameter *A* is raised by a constant factor *g* 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.[2]

Aghion and Howitt show that the introduction of a new technology 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 employ a number of researchers who attempt to discover such a template, in particular through imitating firms that already use the new technology. The share of firms in stage 1 is denoted as n_1.[3] 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. Therefore, there are two ways in which MNCs impact on the economy. First, through the introduction of a new technology into the economy and second as "role models" which indigenous firms try to imitate in order to be able to use the new technology.

In stage 2, firms use the newly acquired template to work out how to implement the new technology and they produce the final output through the application of the new technology. The share of firms in that stage is denoted by n_2.

As derived in Aghion and Howitt the number of firms in stage 1 at any time is

$$n_1 = [\, l_0 + b(k,n_2)](1 - n_1 - n_2) - n_2 \qquad (2)$$

[2] 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).

[3] Of course, the firm introducing the new technology does not have to go through this stage but is immediately in stage 2.

where $1 - n_1 - n_2$ denotes the share of firms that are in neither stage 1 nor stage 2, i.e., which are only producing output using the old technology. The size of n_1 depends on the probability that a firm makes the discovery of a template on its own, l_0, and on the probability that it learns through imitation, b, which depends on a number k of similar firms in the same stage 1 and on the number of firms already in stage 2. In turn, k and n_2 depend positively on the number of multinational companies present in the economy because they represent the prime target for imitation.

The number of firms in stage 2 depends positively on the number of firms in stage 1, subject to a rate of probability that a firm is able to implement the new technology, i.e.,

$$n_2 = l_1 n_1 \qquad (3)$$

As Fig. 1 demonstrates, the number of firms in stage 1 increases steadily up to a maximum, and decreases afterwards due to the flow of firms into the more advanced stage 2. This, in turn, implies that the number of firms in stage 2 increases first slowly, then very rapidly as firms in stage 1 are successful in implementing the new technology. Finally, the curve flattens out so that 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.

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 s 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 skilled labour force increases over time due to schooling and training.

At the beginning of stage 1, following the introduction of the new technology, only a few firms actually attempt to implement it. This implies that the demand for skilled labour is very low, and skilled and unskilled labour are paid the same wage. Later on, however, demand for skilled labour increases steeply, leading to labour-market segmentation in which skilled labour is paid a higher wage. Aghion and Howitt (1998) show that in the segmented labour market demand for unskilled workers is:

$$x_u = \left(\frac{w_u}{a} \right)^{1/a-1} Y \tag{4}$$

while demand for skilled workers is

$$x_s = \left(\frac{w_s}{ag^{a}} \right)^{1/a-1} Y \tag{5}$$

where w_s and w_u denote the wage rates for skilled and unskilled workers respectively, Y is aggregate final output, and g is the technology parameter. Note that x denotes labour demand as well as intermediate inputs produced since labour is assumed to be the only factor of production for intermediate inputs and is used exclusively in the production of intermediate inputs, rather than in the production of final output.

Since the labour force is divided into two categories, there are two labour market clearing conditions, one for skilled and one for unskilled workers respectively, $L_s = n_1 s + n_2 x_s$ and $L_u = L - L_s = (1-n_2)x_u$. This yields wage rates

$$w_s = ag^{a} \left(\frac{n_2 Y}{L_s - n_1 s} \right)^{1-a} \tag{6}$$

for skilled workers and

$$w_u = a \left(\frac{(1-n_2)Y}{L - L_s} \right)^{1-a} \tag{7}$$

for unskilled workers, where $w_u < w_s$ and w_u tends towards zero if L_s increases. 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 Fig. 2. There is a point at which the labour market becomes segmented; the wage for skilled workers increases and the wage for unskilled workers falls towards zero.

What then 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 will be. 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.

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. While the variables considered in our paper are different, the driving mechanism may be considered quite similar. In both cases the development process leads to a change in inequality in a dual economy. According to the Kuznets hypothesis, economic growth makes it more profitable for owners of capital to invest and increases their incomes relative to wages while in the model we adopt, technological change increases demand for highly skilled workers and increases their wages relative to unskilled workers.

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.[4] Multinationals play a key role in the Irish economy, accounting for approximately 47 per cent of employment and 77 per cent of total net output produced in the manufacturing sector in 1995 (Central Statistics Office, 1997). These firms 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 in the annual *Forfás Employment Survey*. The survey includes employment data on the population of firms existing in Ireland, distinguishing between Irish and foreign-owned firms.[5] Table 1 shows the development of the share of employment in foreign-owned multinationals by sector over the period 1979 to 1995. As can be seen, the total employment share has increased constantly over that period, although there are differences across sectors. Over the same period, we observe that the development of wage

[4] The choice of 1979 as a starting point for this analysis is due to data constraints; 1979 is the first year for which the wage data used in this study were available. While there were MNCs in Ireland before 1979 the period analysed may, nevertheless, be considered to be 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 now US-owned companies in high-tech industries which may be assumed to play a major role in introducing new technologies in Ireland (see Ruane and Görg, 1997).

inequality *between sectors*, calculated by the Gini coefficient, resembles an inverted-U shape (Fig. 3).[6] This observation represents the starting point of our econometric analysis. In this paper, however, we analyse the impact of foreign firms on wage inequality by examining the development of inequality in wages for skilled and unskilled labour *within the same manufacturing sector*.

Wage Inequality Between Sectors

Further analysis of inequality between sectors would be of interest; the figures in Table 1 indicate that the importance of foreign firms is not the same in each sector and, since their presence is mainly concentrated within the high-tech sectors, we expect that the innovative processes introduced by MNCs affect sectors differently. Labour productivity and average wages are likely to increase relatively faster in high-tech skilled labour intensive sectors, thus implying an increase in wage inequality *between* manufacturing sectors. Eventually, due to technology spillovers across sectors, wage inequality between sectors would be expected to diminish. Inequality should therefore increase in the initial stages of MNCs presence and decrease thereafter; Fig. 3 confirms this pattern. Wage inequality increased up to 1987 and decreased thereafter. Unfortunately, a thorough statistical analysis of wage inequality between sectors is troublesome because of (i) the small size of the sample - only 17 observations are available; (ii) the unavailability of the whole distribution of wages in each sector - only average wages are accounted for, and (iii) the discrepancy with the theory, which is more concerned with wage inequality between skilled and unskilled labour within the same sector.

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

[6] The Gini coefficient measures inequality between wages in different manufacturing sectors as it is computed using average wages by sector. A similar pattern appears when alternative measures of inequality are used.

Wage Inequality Within Sectors

While an analysis of wage inequality between sectors can provide some preliminary indications of the relationship between MNCs and wage inequality, the theory described above suggests that, within each sector, MNCs and indigenous firms would cohabit, the former bringing new technologies (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 too. Therefore, the theory would lead us to expect an inverted-U shape when wage inequality between skilled and unskilled labour *within* the same sector is measured.

To analyse this, we calculate the wage gap between white-collar and blue-collar workers using average wages w_w and w_b respectively in each sector:

$$INEQ_{i,t} = (w_w - w_b) / w_w \quad . \qquad (8)$$

The *Census of Industrial Production* includes wages for industrial workers and administrative & technical staff by sector which, following Kearney (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). Therefore, the first distinction is widely accepted as a proxy for the second, not least because the former is the one generally identified in the annual censuses in most countries.[7]

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[7] 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 and accounted 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

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.[8] 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 to 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 analyse the development of the wage gap in more detail, we carry out a cross-sectional time-series analysis of manufacturing sectors. We estimate the econometric model:

$$INEQ_{i,t} = b_o + b_1 FOREIGN_{i,t} + b_2 FOREIGN^2_{i,t} + b_3 IMPORT_{t-1} + \ldots + b_4 EDU_{t-1} + b_5 GDPG_{t-1} + e_{i,t} \qquad (9)$$

where *INEQ* is measured as in (8) as the wage gap between blue-collar and white-collar workers in each sector. $FOREIGN_{i,t}$ 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. $FOREIGN^2_{i,t}$ is the square of $FOREIGN_{i,t}$ to allow for the inverted-U shape.

We assume that blue-collar workers are initially unskilled while white-collar workers are skilled. However, this changes over time as new technologies are introduced and blue-collar workers become more skilled in order to be able

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skill-intensity of clerical workers, from being more akin to unskilled labour to being more similar to skilled labour. 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 do not change the analysis significantly.

8 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.

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 will increase but, as blue-collar workers become more skilled, the wage gap reduces and inequality gradually decreases.

This assumption can be partially supported by the theory.[9] 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. This process would lead to an increase, and eventually a decrease, in the wage gap within each sector. Hence, we expect the signs of the estimated coefficients to be positive for *FOREIGN* and negative for $FOREIGN^2$.

We include three variables to control for other effects on wage inequality. Since, as argued above, imports from labour intensive countries can also be expected to increase inequality we include a variable $IMPORT_{t-1}$ representing 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.

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9 This process of "skill improvement" is also validated by the analysis of wages and numbers of clerical workers in Kearney (1997). As pointed out above, she finds that the introduction of computer technologies have changed the skill-intensity of clerical workers. It may be argued that such a process of "skill-improvement" may have also taken place in the case of industrial workers.

EDU_{t-1} and $GDPG_{t-1}$ comprise respectively the enrolment ratio in third-level education and the per capita growth rate of the economy in the previous year.[10] These two variables have been introduced to control for changes in the supply and demand of skilled labour. We can argue that, from equations (6) and (7), the higher the growth rate in the economy the faster the increase in n_2 (since growth stems mainly from high-tech sectors) and the higher the demand for skilled labour, thus generating excess demand in the segmented labour market. Wages for skilled labour would increase (see equation 6), thereby increasing the wage gap. The sign of $GDPG_{t-1}$ is expected to be positive. On the other hand, the higher the enrolment ratio in third-level education, the higher the supply of skilled labour (L_S increases in equation 6), which reduces inequality by raising the supply of skilled labour and decreasing the supply of unskilled labour; therefore the expected sign of EDU_{t-1} is negative.

For education, we construct a 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*. For GDP per capita growth we calculate the difference, in natural logs, between Irish GDP per capita in subsequent years, using data from the Penn World Tables, Mark 5.6 (Summers and Heston, 1991). The three control variables are lagged for one year. Table 4 shows some summary statistics for these variables.

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

10 Note that third-level education includes training of technicians as well as graduates.

of skilled 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 to 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 for the coefficient of the variable *FOREIGN* is positive while the coefficient of $FOREIGN^2$ is negative. This indicates that, as suggested in the theory, an increase in the share of MNCs leads initially to an increase in wage inequality between white-collar and blue-collar workers. This inequality, however, reaches a maximum after which any further increase in the presence of multinationals leads to a decline in wage inequality within sectors.

Inspection of the other variables in the estimations shows that the coefficient for the import variable has a positive and statistically significant sign. As expected, imports from developing countries, which can be assumed to be labour intensive, lead to an increase in wage inequality between skilled and unskilled labour in the economy. Surprisingly, we find a positive and statistically significant coefficient also for the education variable, suggesting that an increase in the 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. The coefficient for the growth variable turns out to be insignificant, i.e., controlling for other effects, growth of GDP per capita does not seem to affect wage inequality.

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 equation (9) under these assumptions (first order autoregression) as suggested by Kmenta (1986). The only difference as compared with the results in Column 1 is the coefficient of *IMPORT*, which turns out to be statistically insignificant in this specification. Most importantly, the coefficients for *FOREIGN* and $FOREIGN^2$ are similar to the previous estimation in their signs, magnitude, and significance levels.

In another step we assume that, instead of imposing constant coefficients over the sectors, the intercept term is allowed to be different for each sector, 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 former case, the sector specific effect is assumed to be an estimable fixed parameter, whereas the latter specification assumes the effect to be random. The results for both specifications are reported in Column 3 (RE) and Column 4 (FE) of Table 5. We prefer the RE technique for two main reasons. First, as Baltagi (1995) points out, the FE model is appropriate if one looks at a fixed sample over the whole period, while the RE model is more applicable in the case of randomly selected individuals from a large population. While we look at a constant set of sectors we would, nevertheless, assume the sample not to be fixed since the number and performance of firms constituting a sector can be expected to change over the period. Second, the FE technique relies on estimating dummy variables for all sectors, and in our case of only 17 years compared with 17 sectors this can lead to estimation problems. As the *F* statistic for the FE specification indicates, the equation is statistically insignificant overall.

Looking at the results for the RE specification we observe that the coefficients for *FOREIGN* and $FOREIGN^2$ are comparable to the results in Columns 1 and 2, supporting the expectation that there is an inverted-U shape relationship between the presence of multinationals and wage inequality between skilled and unskilled workers within the same sector. The import variable has also the expected sign which confirms the expectation that imports from developing countries have a positive effect on wage inequality. Again, we get the surprising result for the education variable - a positive relationship between income inequality and the level of education - while the GDP growth variable is statistically insignificant.

In Table 6 we report results for alternative regressions which did not include the $FOREIGN^2$ term. The estimation procedures were identical to the ones in Columns 1 to 4 in Table 5. The overall statistical insignificance of all the equations indicates that the inclusion of the squared term is vital for these estimations.

V DISCUSSION AND CONCLUSIONS

In this paper we presented an econometric model estimating an inverted-U shape in *within sector* wage inequality with respect to the presence of MNCs in Ireland. The main idea is related to the Kuznets hypothesis that the development process implies first an increase and then a decrease in inequality. Different models, in both the growth and inequality literature, provide an explanation for the inverted-U shape; in this paper, we assume that MNCs through the introduction of new technologies impact on wage inequality in the host country.

To formalise this idea we presented a model developed by Aghion and Howitt (1998) which we re-interpreted in terms of the effect of multinationals on the level of technology in the economy.

Our empirical results for the Irish manufacturing sector between 1979 and 1995 suggest that there is an inverted-U shape in wage inequality. In our 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* and we find 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 analysing the demand for labour, such as Boyle and McCormack (1998) 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 technical 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.

More evidence is needed to support the findings of this paper. In particular, more precise data about the distribution of wages in each sector, and the ratio of skilled to unskilled workers in MNCs and indigenous companies are needed to validate the robustness of the results. In particular, we need to investigate further the effects of education and growth on wage inequality. Why is it that, in our estimations, education seems to increase wage inequality, while GDP growth does not appear to have any significant effect? Furthermore, a comparison of our results with similar studies in other countries experiencing a consistent influx of foreign direct investment would be useful in order to assess whether Ireland stands as an isolated case, or whether our results are supportive of much wider evidence as to how MNCs impact on the host country.

TABLES

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 Irish Economy Expenditure Survey* data

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	.0485	.0482	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

Table 4: Summary Statistics for Employment and GDP Data

	Mean	Standard Deviation	Minimum	Maximum
Imports	0.0257	0.0090	0.0157	0.0425
Education	22.07	6.06	14.26	33.59
GDP Growth	0.0347	0.0199	-0.0043	0.0694

Source: Own estimates derived from various sources

Table 5: Inequality within Sectors: Panel Data Analysis

	(1)	(2)	(3)	(4)
Foreign	0.7197	0.6529	0.6239	-0.0005
	[6.852]***	[4.352]***	[2.321]**	[-0.001]
$Foreign^2$	-0.9193	-0.8407	-0.7866	-0.0872
	[-7.001]***	[-5.056]***	[-2.411]**	[-0.094]
Imports	2.1291	0.0016	2.1701	2.2635
	[1.717]*	[0.002]	[2.126]**	[2.178]**
Edu	0.0042	0.0026	0.0042	0.0039
	[2.276]**	[1.925]*	[2.738]***	[2.507]**
Gdpg	-0.0631	0.0421	-0.0638	-0.0667
	[-0.261]	[0.338]	[-0.322]	[-0.336]
Constant	0.1733	0.2693	0.1851	0.3008
	[2.387]**	[4.407]***	[2.380]**	[1.409]
Sectors, periods	17, 17	17, 17	17, 17	17, 17
Observations	289	289	289	289
Chi^2 (5)	53.54***	37.94***	12.41**	
F (5, 267)				1.35
R^2 overall			0.156	0.025

Notes: 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.

Table 6: Panel Data Analysis: Alternative Specifications

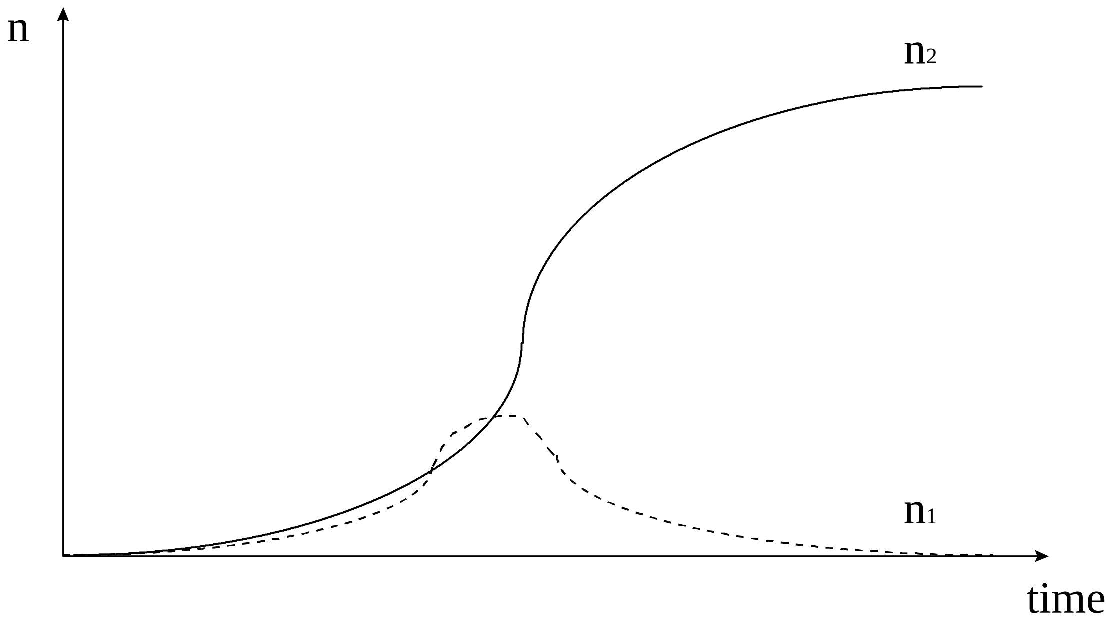
	(1)	(2)	(3)	(4)
Foreign	0.0084	-0.0469	-0.0057	-0.0850
	[0.291]	[-1.323]	[-0.072]	[-0.429]
Imports	2.3643	0.1229	2.3498	2.2682
	[1.763]*	[0.133]	[2.309]**	[2.189]**
Edu	0.0039	0.0023	0.0039	0.0038
	[1.937]*	[1.612]	[2.559]***	[2.554]**
Gdpg	-0.0674	0.0286	-0.0674	-0.0671
	[-0.258]	[0.228]	[-0.340]	[-0.339]
Constant	0.2762	0.3977	0.2825	0.3182
	[3.592]***	[7.241]***	[4.063]***	[2.997]***
Sectors, periods	17, 17	17, 17	17, 17	17, 17
Observations	289	289	289	289
Chi^2 (4)	3.87	7.66	6.62	
F (4, 268)				1.69
R^2 overall			0.012	0.025

Notes: 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.

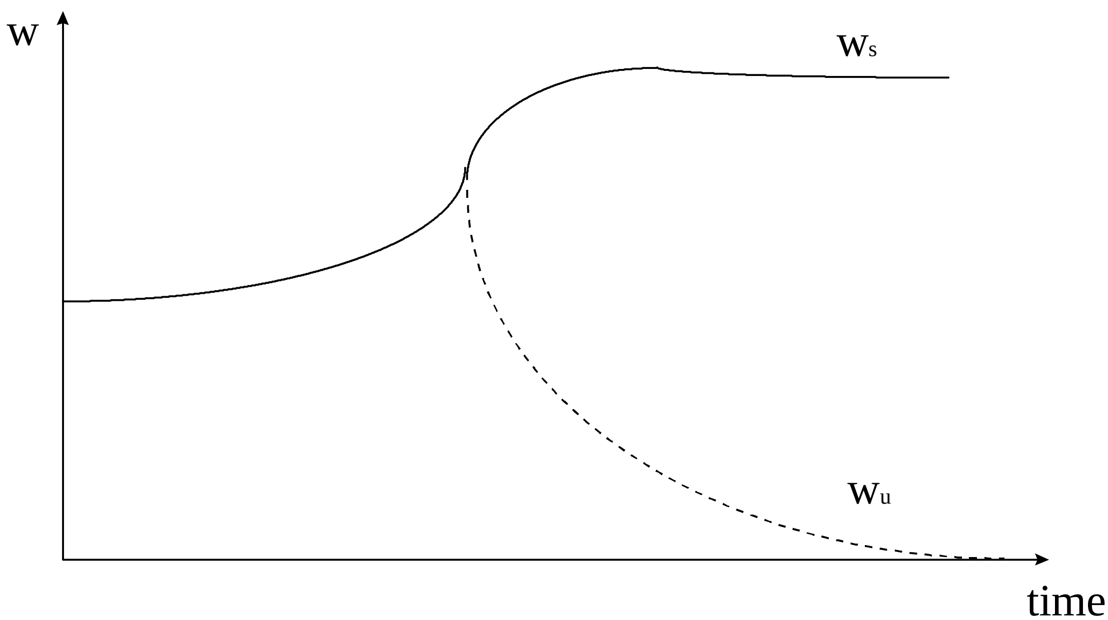
FIGURES

Fig. 1: Shares of Firms in Different Technology Stages



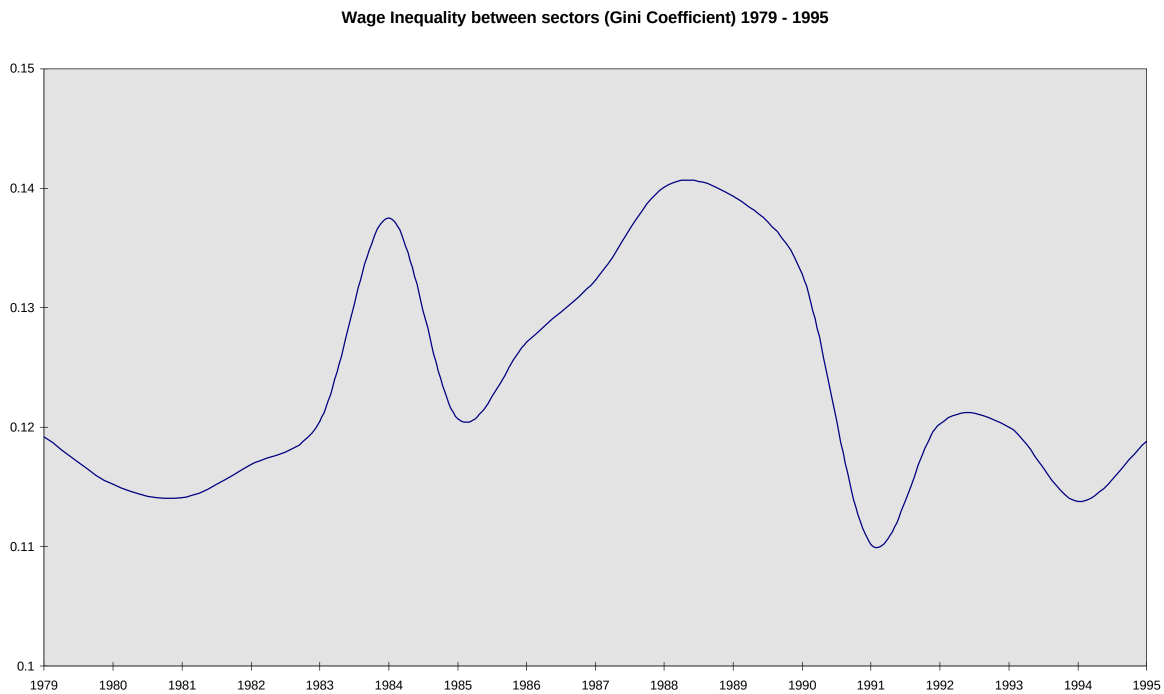
Source: Aghion and Howitt (1998), p. 255

Fig. 2: Development of Wages



Source: Aghion and Howitt (1998), p. 261.

Fig. 3: Wage Inequality Between Sectors (Gini Coefficient) 1979 - 1995



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

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