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**The Route out of the Routine:
Where do the Displaced Routine Workers Go?**

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Editor's Foreword

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Abstract

Over the previous three decades, technological progress has driven a shift in the occupational structure of many countries, including the UK. Some jobs are comprised of a number of tasks which could be replaced by information and communications technology capital. These jobs are referred to as routine in the sense that the tasks performed by workers in them tend to follow a series of instructions, which could be replicated by an appropriately programmed machine. This process is often referred to as routinisation (Autor, Levy and Murnane 2003). Along with the related phenomena of polarisation, much of the discussion has been on the implications of these changes for wage inequality (Goos and Manning 2007, Autor, Katz and Kearney 2006a). However, changes in the occupational structure have potentially important effects on mobility as well, but as yet these effects have not been rigorously analysed. With improving upward mobility often mentioned as an ambition of successive governments, it is important to establish what barriers exist in order to devise policies to overcome them.

One aspect of changes to mobility prospects can be examined by looking at the labour market outcomes of employees displaced by routinisation. A key question is whether these workers are able to move to well-paid non-routine jobs, and if they are, what factors contribute to this upward mobility? Using data from the National Child Development Study (NCDS), this paper presents a mobility analysis of these routine workers between 1981 and 2004. As expected, periods where the employment share of routine jobs fell markedly across the entire economy were periods which witnessed increased mobility of routine workers towards both high and low wage non-routine jobs. The relationship between routinisation and mobility is mediated through the qualification levels, specific skills and experience of workers.

1. Introduction

Over the previous three decades, technological progress has driven a shift in the occupational structure of many countries, including the UK. Some jobs comprise of a number of tasks which could be replaced by information and communications technology (ICT) capital. As the price of such technology falls, so too does employment in these jobs. These jobs are referred to as routine in the sense that the tasks performed by workers in them tend to follow a series of instructions, which could be replicated by an appropriately programmed machine. This process is often referred to as routinisation (Autor, Levy and Murnane 2003). Along with the related phenomena of polarisation – which identifies routine occupations as mostly middle-wage jobs – much of the discussion has been on the implications of these changes for wage inequality (Autor, Katz and Kearney 2006a, Goos and Manning 2007). However, changes in the occupational structure have potentially important effects on mobility as well, but as yet these effects have not been rigorously analysed. With improving upward mobility often mentioned as an ambition of successive governments, it is important to establish what barriers exist in order to overcome them.

There are numerous dimensions to the effect routinisation may have on mobility. Established career paths may be affected by the decline in middle-wage routine occupations, with workers struggling to move up to that level as the number of jobs opportunities falls. This bottleneck could create two segments of jobs, with vacancies of well-paid, high skill jobs above the bottleneck being filled with increasingly well-qualified new entrants rather than through the career progression of older workers in less good jobs. A second aspect of this is to consider the mobility (and limits to mobility) of routine job employees displaced by routinisation. As firms' demand for these routine workers declines, it is insightful to learn how the labour market treats them afterwards. A key question is whether these workers are able to move to well-paid non-routine jobs, and if they are, what factors contribute to this upward mobility. This aspect of mobility is the focus of this paper, by looking at occupational transitions of these routine workers between 1981 and 2004.

The paper is arranged as follows. The next section discusses a theoretical framework for considering mobility in a routinising labour market. This model

identifies the key factors which affect occupational mobility, including both changes in the occupational structure and more general career progression. This model can be seen as a benchmark against which the empirical mobility analysis can be compared. Discrepancies between the model and the data may suggest the existence of barriers to mobility not explained by differences in human capital. Section three describes the methodology to analyse the destination of displaced workers using a longitudinal dataset, described in section four. Section five presents the estimation results, which are discussed and interpreted using some simple examples in section six. For the less technically inclined, this latter section may be useful to get an understanding of the nature of the results without working through the econometrics. Section seven concludes and identifies directions for future research.

2. A Model of Occupational Choice

Autor, Katz and Kearney (2006b) present a model of the economy where production depends on the input of three types of labour – abstract, routine and service – and capital. Routine labour is a perfect substitute for capital in the production process, so as it becomes cheaper, it drives down routine employment and wages. Holmes (2011) extends this model to include four types of labour: professional, managerial, routine and service. This expands the abstract labour category in Autor, Katz and Kearney’s model to include managerial occupations and professional occupations, the latter requiring accreditation or qualifications. This extended model considered here allows for the possibility that routine workers can move to high skill non-routine occupations, which is not allowed in the original model. Furthermore, it introduces the possibility of career progression by considering multiple time periods, so that workers may develop experience which allows them to advance to better jobs as they get older. Therefore, there are two forms of occupational moves in the model: career mobility and routinisation-driven mobility. Finally, the model looks at the experiences of different generations of workers by allowing for new entrants into the labour market. The purpose of this section is not to completely restate the model, but to set out its main implications for the mobility analysis conducted in this paper.

Workers differ in their levels of education attainment – they may be either university graduates, high school graduates or unqualified. Individuals with higher attainment are able to work in the better jobs, either because these jobs require higher

levels of skills developed through more education, or because education acts as a signal in a screening processes where the most able invest in more education. University graduates are able to supply their labour to either managerial or professional occupations. High school graduates supply their labour to either managerial or routine occupations. Finally, the unqualified are able to supply their labour to either routine or service occupations.

Within each educational category, workers differ in their productivity in each occupation. This relative productivity can reflect a number of different dimensions. First, it can represent differences in general cognitive abilities. For example, some people may be innately better problem solvers, making them more productive managers, or better tool-handling skills, making them better process operatives (a routine occupation). Second, individuals develop capabilities through experience that allows for progression to better jobs, leading to the creation of a career. For example, working for a time in a workshop is considered necessary experience for promotion to the position of shop foreman. This type of mobility was introduced in a formal model by Sicherman and Galor (1990). This is included in the model by allowing relative productivity in better occupations to increase as workers get older. Third, individuals develop specific skills from working in a particular occupation, where these skills are only employable within that occupation. This is included in the model by allowing relative productivity of the job currently being performed to increase as the worker spends more time in it.

Wages in each occupation are set per effective unit of labour input, so more productive workers earn more for the same time input. In the absence of routinisation (i.e. with stable relative wage rates) mobility would be in the form of career progression, as individuals becomes relatively more productive in better occupations, and as a result may move occupations as they get older ¹.

A change in the relative wages of the different occupations alters supply patterns and generates additional mobility. For example, an exogenous fall in the wage of routine workers (caused, as in the case of routinisation, by a fall in the price of ICT capital for which routine labour is substitutable) would lead some unqualified workers to move to service occupations while some high school graduates would

¹ Assuming that this effect outweighs the routine occupation specific skill effect.

supply their labour to managerial work². Assuming the service occupation has a lower wage rate, those who make this move will have the lowest relative productivity in routine work. Moreover, assuming that the managerial occupation attracts a higher wage rate, those that make this move would be those with the highest relative productivity in managerial occupations. Therefore, the model predicts not only that routinisation should increase mobility out of routine occupations, but that these moves are mitigated by a number of factors:

- Mobility from routine to managerial occupations should be more likely with higher qualifications. Mobility from routine occupations to service occupations should be less likely with higher qualifications.
- To the extent that older workers (with more labour market experience) become relatively more productive in better occupations over time, then everything else being equal, there will be more mobility towards managerial occupations by older workers, and more mobility towards service occupations by younger workers.
- To the extent that specific skills in routine occupations make workers relatively more productive in those jobs, then everything else being equal, there will be less mobility out of routine occupations by those with more specific skills.

These final two points are connected to the work of Autor and Dorn (2009), who argue that routinisation affects generations differently. Skill specificity makes older workers less likely to move between occupations and more likely to accept falling wages, whilst young workers are less keen to move into those in decline. This has led to routine occupations ‘getting old’. The model presented here allows for two separate effects from aging through the development of both occupation-specific skills and career-progressing experience. We certainly might expect older workers to have more specific experience in routine occupations than younger workers. However, what this model shows is that, once you control for these specific skills, it will be older (appropriately qualified) workers who are more likely to leave routine occupations.

In this paper, we test these different aspects of mobility using a panel data set which follows a cohort of UK workers through the labour market. A final implication of this model is that, as a result of routinisation, patterns of mobility may differ across generations. Younger workers will respond not only to the increasing relative wage of

² This is the sort of occupational mobility that a part of the literature tends to focus on, which starts with the assumption that changes in employer or job arise when there is a shift in an individual’s information set or preferences, or the external labour market environment, such that an alternative occupation yields a higher expected lifetime utility.

non-routine workers but also to the anticipated faster growth of wages in non-routine occupations in the future. As a result, more young high school graduates will supply their labour in the managerial occupation relative to the young generation in the previous period. These implications are not tested in the present paper.

Going from the theoretical model to the data introduces a number of additional considerations. First, occupational choice may be noisy – that is, individuals do not always make good matches and are not completely informed about their own relative abilities. Thus, some mobility recorded in the data may capture this. However, there is no reason to think that such mismatches will necessarily lead to more upward or downward mobility, as individuals could mismatch in both directions.

Second, there may be other transitions not set out by this model, for instance from service occupations to managerial occupations. The model is highly conceptual in the rankings of the four occupational categories, whereas it is perfectly plausible that, for example, a manager of a shop may have worked up from a customer service occupation. Indeed, the huge growth in the managerial class and the widening definition of that occupation will blur some of the clear distinctions made in the model. Equally, some occupations classed as routine (such as a skilled craftsperson) may initially have earned more than many managers or professionals, but the decline in demand for these skills may have pushed them towards the middle of the distribution. It is here that looking at both wage and occupational mobility may prove useful – such a worker may exhibit little occupational mobility but a significant lowering of wage, or they may have changed occupation but maintained a position in the spectrum of wages, or they may have exhibited mobility in both. All of these outcomes are possible within the model set out in Holmes (2011). However, an empirical analysis of wage mobility is outside of the scope of this paper.

3. Methodology

As identified in our model, individuals may move between occupational categories due to career progression, rather than due to displacement caused by routinisation. Therefore, simply looking at the occupational mobility of routine workers over time may capture both those moving due to career motivations, and those displaced by routinisation. Ideally, we would compare two cohort studies, looking at the probability of moving between different occupational categories for a workforce

unaffected by routinisation, and one that entered the labour market just as routine occupations began to decline. However, an appropriate early cohort study does not exist in the UK.

As a result, this paper develops an alternative methodology. The factors affecting transitions from routine occupations are estimated using the logit model, where the independent variables are education, specific experience and two demographic variables (gender and race), running one regression for each final occupation group. As a final explanatory variable, a measure of routinisation is included for each of these periods. This final addition to the model can, at least to an extent, separate out occupation moves caused by routinisation and those caused by general career progression.

Let Y_{it} be a dummy variable which takes value of 1 if the individual i is in the given occupational group Y at the end of period t . Then, the logit model specifies the functional form of the probability distribution over belonging to a certain occupation at the end of the period t as:

$$\Pr(Y_{it} = 1 | X_{it}, R_t) = \frac{\exp(\alpha + \beta X_{it} + f(t) + \theta R_t)}{1 + \exp(\alpha + \beta X_{it} + f(t) + \theta R_t)} = \text{logit}^{-1}(\alpha + \beta X_{it} + f(t) + \theta R_t)$$

Rearranging gives the log odds ratio, z , as a linear function for each individual i in period t :

$$z_{it} = \ln \left(\frac{\Pr(Y_{it} = 1 | X_{it}, R_t)}{1 - \Pr(Y_{it} = 1 | X_{it}, R_t)} \right) = \alpha + \beta X_{it} + f(t) + \theta R_t \quad (1)$$

where X_{it} is a vector of educational attainment, specific experience and other personal characteristics of individual i (including any interaction terms), in period t , the period of transition, and R is a measure of routinisation (or the change in the occupational structure) in that period. The time period may enter the equation in a number of forms, but the baseline model includes it as a linear trend and is interpreted as the accumulation of career-progressing experience.

4. Data

This model is estimated using the National Child Development Study (NCDS). The members of the NCDS study were all born in a single week in March 1958. Data has

been collected on these members in a series of waves. The most useful waves for assessing labour market outcomes over a period where routinisation has taken place are between the fourth and seventh waves, taken in 1981, 1991, 1999-2000 and 2004-5 respectively. The fourth wave is the first one taken after the school leaving age (respondents were aged 23) and records early labour market experience. The seventh wave was completed in 2004-5 (respondents were aged 46-47), and has the most recent data on wages, employment and education. It is possible to construct an entire working life history over this time period using responses from all four waves, including periods of employment, unemployment, self-employment and non-participation for a number of reasons such as sickness or further education. As with all longitudinal studies, there is missing data. The sample size is around 12,000 for the fourth wave, and around 10,000 for the seventh wave, of which employment data is available for a subset of these observations. Just under 5000 individuals report employment data in both the fourth and seventh waves, though this sample increases if we look at those who were non-employed or unemployed in one of the waves. The data suggests five periods of transition for this analysis: 1981-1986, 1986-1991, 1991-1995, 1995-1999 and 1999-2004. These periods were chosen so that four of them coincided with the actual survey years of the dataset, and the remainder (1986 and 1995) fell in the mid-point between two surveys.

4.1 Occupational mobility

Occupations of employment are measured using the narrowest available occupational coding. One problem with doing this over a long period of time is that the system of coding occupations has changed three times since 1980. The 1981 wave uses the KOS (Key Occupations for Statistical Purposes) system of job title classification, which categorises occupations within the 18 CODOT (Classification of Occupation and Directory of Occupational Titles) major groups, while the 1991 and 1999 surveys use SOC90 and the 2004 wave uses the most recent SOC2000 classification. The SOC2000 coding system of occupations has a four level classification system, from major group (first digit) to unit group (fourth digit). To make data comparable between 1981 and 2004, a conversion system was derived between KOS and SOC2000 codes, using the descriptions of occupations provided for each group. The conversion is not always perfect (see Holmes 2010 for a discussion). In some cases a category in SOC2000 could apply to several categories under KOS (and vice versa)

and subjective judgements have been made. In some cases, observation have been dropped because it was not possible to place one KOS code into a single SOC2000 code. Total exclusions on this basis account for 12.43% at the minor group (three-digit) level for the 1981 survey. A similar conversion was created between SOC90 and SOC2000³. These two classification systems had much more overlap in terms of the descriptions of each category. A conversion was made from each SOC90 occupation to a 4-digit SOC2000 category, where descriptions were on a similar level of aggregation. These were then reduced into 3-digit categories which are used in the analysis.

Each 3-digit category was assigned to one of the six occupational categories, up from the four categories discussed in the model. This adds an intermediate occupation category to the two high skill non-routine occupations on the basis that such occupations (including associate professionals and technicians) had different entry requirements than professionals and potentially different employment trends than managerial occupations. Moreover, a small category for manual non-routine occupations was added to distinguish this sort of low wage non-routine work from service occupations.

The allocation between different occupational categories were based on the wages (using average values from NCDS data in the 1981 and 2004 waves), description and change in employment share (using Labour Force Survey data). Aside from a few obvious categories (such as those which are clearly professional from the descriptions), any occupation which experienced a decline in employment share is considered to be a routine occupation. Looking at the wages and descriptions is used as a common sense check – all these occupations have middle range wages and their descriptions suggest the work involves administrative or manual processes which could be replaced by computer technology. The occupational categories are shown in Table A1.

4.2 *Educational attainment*

Across the four waves of the NCDS used in this paper, there are numerous systems for recording educational achievement, including detailed data on a wide range of vocational courses which have declined in importance in recent years. As a way to bring all of this data together, the highest NVQ equivalent level across time is

³ Both conversions are available upon request.

recorded⁴. Each individual has two educational variables – a highest NVQ level in academic courses and a highest NVQ level in vocational courses, with both ranging from 0-5. The data is cleaned so that NVQ levels do not decline over time.

4.3 *Experience and specific skills*

General experience is captured by age, or period of transition, which ranged from 1 to 5. Specific experience within a routine occupation is included below using a scale measure from 0 to 4. Each previous period adds one to this measure if the individual was in an routine occupation and the beginning and the end of that period. This is likely to be a conservative measure of experience in specific routine occupations, however, it is significantly simpler than checking over all employment histories and counting the total number of years in routine occupations.

Specific experience and the time period are positively correlated, as would be expected, with a correlation coefficient of 0.672. Within each period of transition, there is sufficient variety in existing routine experience that issues relating to multicollinearity would not be an immediate concern – around 55% of the total variance of specific experience is not accounted for by age.

4.4 *Routinisation*

The measure of routinisation comes from data from the Labour Force Survey (LFS). Data on employment has been collected by the LFS since 1973 on a yearly basis until 1992, then on a quarterly basis. Wage data has been available from the LFS since 1993. The sample is much larger than any UK cohort study, as it looks at around 60,000 households, leading to approximately 120,000-130,000 individual observations. Using these data, the measure of routinisation in each of these time periods is the changes in employment of routine occupations across the whole labour market. Table A2 shows the change in the different occupational groups over each period.

Routinisation had its largest effects in the late 1980s and the early 2000s, and had much less of an effect in the 1990s. The process of routinisation is assumed to directly affect the employment share of routine workers and is exogenous. It seems sensible to look at decline rates rather than absolute declines – a 2% fall in employment share will have a much larger effect on occupational mobility if the

⁴ The full table of NVQ equivalent qualifications can be found here: <http://www.gos.gov.uk/497745/docs/379399/428699/469541/qualificationsguidance>

initial employment share was 4% than if it were 20%. Thus, the routinisation variable takes the following values:

Year	1981-86	1986-91	1991-95	1995-99	1999-2004
Period of transition, <i>t</i>	1	2	3	4	5
Change in employment share	-4.30%	-15.29%	-3.27%	-1.90%	-6.27%
Rate of decline	-6.55%	-24.91%	-7.09%	-4.44%	-15.32%
Routinisation	0.0655	0.2491	0.0709	0.0444	0.1532

Source: LFS, own calculations

Periods of transition and routinisation are barely correlated – they have a correlation coefficient of -0.05 – which means we can be confident that the routinisation index will not capture any effects of career progression when both are included in the model. Thus, this method allows for the mobility effects of routinisation to be distinguished from those that would already occur over the working life.

5. Results

5.1 *The baseline estimation*

The following equation is estimated based on (1):

$$Z_i = \alpha + \beta_1 FEMALE_i + \beta_2 NONWHITE_i + \beta_3 ACADEMIC_i + \beta_3 VOCATIONAL_i + \gamma PERIOD_i + \mu SPECIFIC_i + \theta ROUTINISATION + \varepsilon_i \quad (2)$$

Periods are stacked, so *i* denotes an individual-time period pair. The qualification variables are dummies for each NVQ level, and dummies for gender and race are included. The period variable takes a values between 1 and 5. SPECIFIC is the routine occupation specific experience variables respectively. Table A3 gives results for each eventual destination occupation, displaying the estimated coefficients and their significance⁵. The reference group is a white male with both level 3 vocational and academic qualifications.

First, Table A3 shows that gender is a significant predictor of transitions from routine occupations, except toward the professions. Women are more likely than men to move into service or intermediate occupations, but less likely than men to move

⁵ Estimated coefficients in a non-linear model cannot be interpreted as marginal effects in the same way as they would be in a linear model. The marginal effects depend on the values of the other independent variables. Consequently, the focus here is on identifying variables which have a significant effect on mobility, and not on the magnitude of their estimated coefficients. The next section illustrates the size of the marginal effects using some examples.

into non-routine manual or management occupations. Race, on the other hand, has little significant influence on transition probabilities, except towards service occupations. Second, mobility is influenced by working experience. The negative term on routine occupational experience is consistent with the idea that increasing specific skills through performing a certain type of job decreases mobility due to the potential for lost earnings. After controlling for specific experience, the evidence on the role of general labour market experience is more mixed. Older workers are less likely to move to intermediate or professional occupations as they get older. These sorts of upward career moves are perhaps best explained through educational attainment, discussed below, rather than through the accumulation of experience in the labour market. Age has no effect on the likelihood of moving to a managerial position or a service occupation. Finally, individuals are more likely to move to non-routine manual work when older.

For mobility into professional, managerial and intermediate occupations, academic qualifications act in predictable ways – higher qualifications increase the probability of moving and lower qualifications decrease the probability of moving. That said, level 2 academic qualifications do not have a significantly different effect from level 3 academic qualifications in terms of mobility, aside from the case of professional occupations. Vocational qualifications at any level below level 4 are not significantly different in terms of their effect on mobility – that is those at level 3 are not more or less likely to make a given transition than those at levels 0, 1 and 2. This is perhaps surprising, given the supposed role of level 3 vocational qualifications as a mechanism for creating upward mobility. Achieving level 4 or higher improves the probability of moving to one of the better occupations. Most qualifications, regardless of level or type, do not have a significant effect on transitions from routine occupations to service or non-routine manual occupations, with a couple of exceptions (low level academic qualifications for transitions to service occupations). We might suspect that those with higher qualifications would be significantly less likely to move to lower skill occupations, however, this is not the case, with the one exception of level 4 vocational qualifications for non-routine manual occupations.

Finally, routinisation has a significant effect on mobility, entering as a positive term for most non-routine occupations and a negative term for routine occupations. The exception is towards managerial occupations, which displaced routine workers appear to not be any more likely to move towards, regardless of how the occupational

structure is changing. This is broadly consistent with the theoretical model and suggests that some displaced routine workers are moving to good jobs.

5.2 *Interaction terms*

Two alternative specifications are used to test the effect of different variables when conditioned on routinisation.. Multiplicative interaction terms are regularly used in statistical analyses where context may alter the effect of an independent variable, leading to conditional hypotheses. These are introduced here to see whether certain types of individuals do better or worse out of the loss of routine occupations. The first set of regressions looks to see whether certain qualifications enabled individuals to move upwards to better jobs as routine jobs were lost. The second set looks at whether general and occupation specific experience makes individuals less likely to move from routine occupations as the process of routinisation takes place, in the manner discussed by Autor and Dorn (2009).

However, while such analyses are commonplace, the results they produce and inferences drawn are often flawed. There have been numerous contributions about the correct interpretation of results both within the economics literature (see for example, Ai and Norton 2003, which has particular relevance to non-linear models such as the logit model used in this paper) as well as other social science disciplines (e.g. Braumoller 2004, Brambor, Clark and Golder 2006).

Following Brambor, Clark and Golder's checklist of good practice, the estimated models include all relevant terms, including the constitutive terms alone as well as all two-way, three-way and higher interactions. As with the baseline model, estimated coefficients in this logit model are not marginal effects. The size of interaction effects, like marginal effects, depends on the other independent variables. However, even taking the approach of the previous section (focusing on identifying significant effects rather than discussing magnitude) is further complicated. Ai and Norton (2003) demonstrate that in a logit model with interaction, the sign on the interacted term coefficient is not always the same as the direction of the interaction effect. Moreover, a zero coefficient on the interaction term is not the same thing as a zero interaction effect. Finally, the standard error of the interaction effect is not the same as the standard error found on the interaction term coefficients. Hence, simply looking at the sign and significance of estimated coefficients is not enough to describe the effect of each independent variable fully. Consequently, their methodology is

followed for deriving marginal and interaction effects via differentiation of the estimated probability functions, and for computing the standard error of this estimated effect using the delta method. These results are discussed below.

5.3 *Routinisation, career progression and skill specificity*

The stage of an individual's career and their prior experience in the labour market may have bearings on the way routinisation affects mobility. In the baseline model, skill specificity had a negative effect on transitions out of routine occupations and individuals became less upwardly mobile in later periods, suggesting that after controlling for qualifications, career progression from routine occupations declined with age. Our theoretical model predicts that both variables should have an effect in routinisation-driven mobility. The analysis reported in Table A4, includes interaction terms between routinisation, specific experience in routine occupations (ROUTINE EXP) and the period of transition (PERIOD).

Again, the non-interacted terms have similar effects to the baseline model. The marginal effects of PERIOD, SPECIFIC and ROUTINISATION (that is, the rate of change of the probability of a given transition following a change in one of these variables, or first derivative) as well as the interaction effect (the rate of change of these first derivatives following an increase in of the other variables, or the cross derivative) are calculated. Appendix 2 shows the estimated marginal and interaction effects. In these graphs, each point represents an individual with certain observable characteristics (gender, age, qualifications, etc.). Their initial probability of making the transition in question is shown along the x-axis. The marginal or interaction effect of the variable of interest is shown along the y-axis. A standard error and t-statistic is calculated for each effect. If the magnitude of the latter exceeds 1.96, the effect is significant at the 95% confidence level. These diagrams show that marginal and interaction effects of a variable may be positive or negative for different types of worker. Moreover, some effects for a given variable may be statistically significant, while others are not. The direction and significance of these effects does not always accord with the direction and significance of the relevant estimated coefficient in Table A4.

Figures A1.1 to A1.3 show that specific skill accumulation and age have significant effects on the probability of remaining in a routine occupation, whereas routinisation has no marginal effects. Workers with more specific skills are less likely

to move to other occupations, as would be expected. Figure A1.5 shows that these effects are even more strongly negative in periods where more routine occupations are disappearing. There are both positive and negative marginal effects resulting from being older, as well as a number of workers for whom age has no significant marginal effect. Figure A1.4 shows that the degree of routinisation in a given time period may determine whether this is positive or negative – the interaction effect between age and routinisation is generally positive and significant, so periods of routinisation make it more likely that older workers will move to a different occupations.

Figures A2 to A4 show the equivalent marginal and interaction effects when managerial, intermediate and service occupations are the final destination. Professional occupations are omitted here – the next section shows the important role played by having the appropriate qualifications for making this transition. In comparison, working experience has little role in explaining differences in the probability of making this transition. For all three of the occupations shown, the marginal and interaction effects tend to have the opposite sign to the routine occupation estimation, although the number of effects which are statistically significant varies across each transition. For example, the negative interaction effect between specific skills and routinisation is significant for a majority of observations for managerial transitions, but is only found for a minority of intermediate occupations.

To give an overall sense of these estimations, in the aftermath of a decline in routine occupations, many older workers are more likely to move to managerial, intermediate and service occupations. This result for managerial occupations is interesting because up until this point in the analysis, the routinisation effect on mobility leading to transitions to these jobs has been insignificant. One explanation for this might be that, following routinisation, young workers are significantly less likely, and older workers more likely, to move to managerial jobs. Not conditioning on age conceals this variation and leads to average effects across all ages close to zero. Similarly, skill specificity reduces the likelihood of moving to these occupations. The interaction effects shows that in many cases, this effect is significantly stronger following routinisation.

These results present a more complicated pattern than in Autor and Dorn (2009), who argue that routine occupations would ‘get older’ due to the process of routinisation. In some ways, this is true – individuals with more experience in routine

occupations seem less likely to move to growing non-routine occupations, and there is a positive correlation between age and specific experience. However, after controlling for experience in routine occupations, many older workers appear to be more mobile, moving to managerial, intermediate and service occupations in the aftermath of routinisation.

5.4 *Routinisation and qualifications*

In this section, qualifications and routinisation are interacted to find whether certain qualifications make workers more or less likely to make certain transitions following routinisation. The number of qualification variables is reduced to three dummies: vocational at level 4 and above, academic at level 4 and above and academic at level 2 or 3. This is based on the results in Table A3, where vocational qualifications below level 3 did not have significant explanatory power on mobility relative to those at level 3, in most cases. Moreover, level 2 academic qualifications did not have significant explanatory power on mobility relative to level 3 academic qualifications. Reducing the number of qualification dummy variables is convenient to limit the number of interaction terms – in the extended model, there are three qualification variables to interact with routinisation, leading to six two-way interaction terms, three three-way interaction terms and a single four-way interaction term. However, any term with both academic qualification dummies in it must be equal to zero.

Table A5 shows the results of these regressions. Most of the non-interacted independent variables have similar effects to those under the baseline model. The marginal effects are calculated of qualifications and routinisation, and interaction terms between qualifications and interactions as in section 5.3. These estimates are shown in Appendix 3.

Figures A5.1 to A5.4 show the marginal effects of qualifications and routinisation on the probability of remaining in a routine occupation. The marginal effects show that higher qualifications increase the likelihood of moving out of routine occupations in most cases. Moreover, the interaction effects show that following routinisation, this effect is stronger for those with either level 2-3 or level 4-5 academic qualification. However, few significant interaction effects are found between vocational qualifications and routinisation.

Figures A6 to A9 show the marginal and interaction effects associated with transitions to professional, managerial, intermediate and service occupations. Higher

qualifications generally seem to have predictable marginal effects on mobility to the professional, managerial and intermediate occupations. Higher qualifications do not seem to make it less likely that individuals will not move to lower wage service work, however. Moreover, looking at the interaction effects shows that certain types of individuals are more mobile as a consequence of routinisation.

These interaction effects suggest that displaced individuals only progress to growing higher skilled non-routine occupations if they are appropriately qualified. For transition to professional occupations, degree and higher qualifications generally have positive significant effects, suggesting that there are some routine workers with high academic qualifications who move to appropriate employment for their skills following displacement. Similarly, for intermediate occupations, some individuals with level 2 and 3 academic qualifications or level 4 vocational qualification are able to move to better jobs when routine occupations are lost. As with the baseline model, however, routinisation had no effect on transitions to managerial occupations, regardless of qualification. Displaced routine workers seem only to be able to move to managerial occupations if they have sufficient in-work experience and the associated informally learnt skills and on-the-job training, rather than formal qualifications.

Again, there is little evidence in these estimations that higher qualifications significantly reduce the probability of being displaced from a routine occupation to a service occupation, with hardly any of the estimated interaction effects being significantly different from zero. Meanwhile, the marginal effect on routinisation is significant and positive. This indicates that all displaced workers, regardless of educational attainment, are more likely to move to service jobs as a result of routinisation. This is surprising, given the model, as we would expect the least qualified to move to service occupations as the occupational structure changes. Two possible explanations for this immediately occurs. First, it could be that while on average service occupations are less skilled and earn a lower wage, some displaced routine workers, particularly those who are more qualified, are moving to above average service jobs. Second, it could be that there are some barriers to upward mobility for displaced routine workers that are not accounted for in the econometric model, i.e. not connected to observable characteristics, education and skills.

6. How Big are These Effects?

The marginal and interaction effects shown in Appendices 2 and 3 and discussed in the above section show that the probability of transition to non-routine occupations following a change in the occupational structure is significantly affected by a number of individual level skill, experience and qualification characteristics. However, it is not immediately obvious how large these effects are. In this section, a series of examples are provided to give an indication of the size of the effects.

6.1 *Intermediate level qualifications*

The first comparison is made between those with no qualifications and those with level 2-3 academic qualifications, using the interaction model with qualifications. Everything else is held constant – the predicted probabilities are for the transitions of a white male between the ages of 33 and 38, who has worked in a routine occupation for one prior period. These are shown in Table 1, which gives an idea of the size of the effects discussed in the previous section.

The first thing the table shows is that in any five year period, the overwhelming majority of individuals do not leave routine occupations. In the absence of routinisation, around 6.5% of low skilled and 8.5% of middle skilled workers leave these occupations. Many of these moves appear to be some form of career progression (i.e. towards intermediate and managerial occupations), with higher qualifications significantly increasing the likelihood of this (as shown in the column labelled ‘marginal effect’). The second thing it shows is the effect of a 10% decline in routine occupations on mobility.

Table 1: Predicted probabilities of transition – intermediate level qualifications

	0 % routinisation			10% routinisation			
Occupation	No quals	Level 2-3	Marginal effect	No quals	Level 2-3	Marginal effect	Interaction effect
Professional	0.6%	0.5%	-0.1%	0.6%	0.9%	0.3%	0.4%
Managerial	1.3%	3.0%	1.7%*	1.5%	3.7%	2.2%*	0.5%
Intermediate	1.3%	2.3%	1.0%*	1.1%	2.8%	1.7%*	0.7%*
Routine	93.5%	91.5%	-2.0%*	92.2%	89.0%	-3.2%*	-1.2%*
Service	1.1%	1.2%	0.1%	1.5%	1.5%	0.0%	-0.1%

Note: * indicates the effect is significant

This causes additional mobility across all qualification levels (shown by the decline in the probability of staying in a routine occupation for both levels). Just over

1% more low qualification routine workers and around 2.5% level 2-3 workers leave following this decline in occupations – far less than the total decline in jobs. For the more qualified workers, the larger decrease in the probability of remaining in a routine occupation and larger increase in the probability of moving to an intermediate occupation are higher following routinisation (showed by the ‘interaction effect’ column), suggests this is the main destination for those displaced.

6.2 Higher education

Table 2 shows the changes in the predicted probabilities of transition for the same benchmark individual if they moved from level 2-3 academic qualifications to level 4-5 qualifications, such as a university degree.

Table 2: Predicted probabilities of transition – higher academic qualifications

	0 % routinisation			10% routinisation			
Occupation	Level 2-3	Level 4-5	Marginal effect	Level 2-3	Level 4-5	Marginal effect	Interaction effect
Professional	0.5%	3.5%	3.0%*	0.9%	7.6%	6.7%*	3.7%*
Managerial	3.0%	9.4%	6.4%*	3.7%	6.5%	2.8%*	-3.6%
Intermediate	2.3%	5.6%	3.3%*	2.8%	6.1%	3.3%*	0.0%
Routine	91.5%	85.7%	-5.8%*	89.0%	78.4%	-11.6%*	-5.8%*
Service	1.2%	0.5%	-0.7%	1.5%	0.9%	-0.6%	0.1%

Note: * indicates the effect is significant

In the absence of routinisation, around 15% of level 4 and 5 qualified routine workers move to new occupations, which is significantly more than those at level 2 and 3. Almost all of this appears to be upward career progression to professional, managerial and intermediate occupations. With a 10% reduction in the number of routine jobs, this changes to around 22%, and a much larger increase than for the less qualified. This implies that the most qualified are best placed to progress to better jobs after being displaced, as would be expected. There is a significant increase in the estimated number of transitions to professional occupations as a result of routinisation (from 3% to nearly 7%), suggesting this as the main destination for displaced degree educated routine workers.

In both cases of academic qualifications, progression to managerial occupations is not more likely as a result of routinisation. It is not immediately clear why more educated displaced routine workers are not able to move managerial

occupations when displaced from their jobs, although it suggests non-human capital barriers to this form of mobility.

6.3 *Higher vocational qualifications*

Although it's possible to talk about the marginal effects of vocational qualifications, few individuals have very high vocational qualifications and no academic qualifications, so the comparison shown in Table 3 is for workers with level 2 and 3 academic qualifications and either with or without level 4-5 vocational qualifications. 12% of routine workers holding level 4-5 vocational qualifications leave these occupations each period, generally to progress to one of the higher occupations. However, this is less than those with similarly graded academic qualifications.

Table 3: Predicted probabilities of transition – higher vocational qualifications

	0 % routinisation			10% routinisation			
Occupation	Level 2-3 academic	Level 2-3 academic + Level 4-5 vocational	Marginal effect	Level 2-3 academic	Level 2-3 academic + Level 4-5 vocational	Marginal effect	Interaction effect
Professional	0.5%	3.1%	2.6%*	0.9%	3.8%	2.9%*	0.3%
Managerial	3.0%	6.8%	3.8%*	3.7%	7.6%	3.9%*	0.1%
Intermediate	2.3%	2.5%	0.2%	2.8%	4.4%	1.6%*	1.4%*
Routine	91.5%	88.1%	-3.4%*	89.0%	83.2%	-5.8%*	-2.4%*
Service	1.2%	1.0%	-0.2%	1.5%	1.1%	-0.4%	-0.2%

Note: * indicates the effect is significant

Following a 10% decrease in routine occupations, this figure increases to around 17%. Interestingly, the only transition which becomes increasingly likely for such workers are intermediate occupations, whereas level 4-5 academic qualification tend to increase mobility towards the professions. Again, routinisation appears to have no effect on the likelihood of moving to managerial occupations

6.4 *Specific skills*

Table 4 shows the estimated probabilities of transition for a white male with both level 2-3 academic and vocational training between the ages of 28 and 33.

Table 4: Predicted probabilities of transition – specific experience and skills

Occupation	0 % routinisation			10% routinisation			Interaction effect
	No specific experience	5 years specific experience	Marginal effect	No specific experience	5 years specific experience	Marginal effect	
Managerial	4.7%	2.1%	-2.6%*	5.4%	2.8%	-2.6%*	0.0%
Intermediate	4.1%	3.4%	-0.7%*	4.8%	3.5%	-1.3%*	-0.6%
Routine	89.4%	91.9%	2.5%*	84.0%	91.0%	7.0%*	4.5%*
Service	0.8%	0.8%	0.0%	1.3%	0.8%	-0.5%*	-0.5%*

Note: * indicates the effect is significant

It shows that an extra period of experience in routine occupations – the proxy for specific skill acquisition – reduces the probability of leaving a routine occupation by 2.5%. Moreover, the additional experience is even more important following a 10% decline in routine jobs. Those with this experience are barely more mobile following this change, whereas an additional 6% more of those with less specific skills are estimated to leave routine occupations. The only occupational group with a significant interaction effect is service, suggesting that those with little specific experience are more likely to move downwards following routinisation. The percentages are not large however, even if they are significant. This indicates that while specific experience may decrease mobility following routinisation, it is other factors which are explaining destinations of those that are displaced.

6.5 Working experience

Table 5 shows the estimated probabilities of transition for a white male with both level 3 academic and vocational training and no specific experience. Age is a proxy for labour market experience, which itself captures more general skills or knowledge which facilitates upward career progression.

Table 5: Predicted probabilities of transition – work experience and age

Occupation	0 % routinisation			10% routinisation			Interaction effect
	Aged 28-33	Aged 33-38	Marginal effect	Aged 28-33	Aged 33-38	Marginal effect	
Managerial	4.7%	3.2%	-1.5%*	5.4%	5.1%	-0.3%*	1.2%*
Intermediate	4.1%	2.6%	-1.5%*	4.8%	4.1%	-0.7%*	0.8%*
Routine	89.4%	92.8%	3.4%*	84.0%	86.0%	2.0%*	-1.4%*
Service	0.8%	0.6%	-0.2%	1.3%	1.2%	-0.1%	0.1%

Note: * indicates the effect is significant

It shows that, in the absence of routinisation, younger workers are more mobile. Around 11% of younger workers (aged 28-33) leave routine occupations each period, compared to just over 7% of workers five years older. Most leave for intermediate and managerial occupations. Decreasing the number of routine jobs available by 10% increases mobility from routine occupations, but more so for older workers – 5% of younger workers move on following routinisation, whereas an additional 7% of older workers move on. The significance of the interaction effect on managerial and intermediate occupations suggests that many routine workers with more general labour market experience and skills move towards these occupations after displacement. As noted previously, it appears to be non-formally accredited skills and experience, rather than formal qualifications, which lead to transitions to managerial occupations following routinisation. There is also an increase in mobility towards service occupations, but not a significant difference across the two groups.

6.6 *Transition to service occupations*

One final point to note is that across all the interaction model estimates, there is no evidence that higher qualifications reduce the probability of moving to lower wage service occupations. In all cases, the marginal effect of routinisation is to increase the likelihood of making such a transition regardless of level of education. This suggests the presence of some non-human capital barriers to mobility, which mean that some well-trained or well-qualified workers are forced into less good occupations while others similar to them do make upward transitions.

7. Conclusion

Routinisation, the process where routine task based occupations are replaced with increasingly cheap ICT capital has altered the occupational structure of many labour markets. Some authors have commented that this has led to a polarisation of job markets with more individuals being employed in high wage and low wage non-routine occupations, at the expense of middling wage routine occupations. So far, very little attention has been paid to the effects on mobility resulting from this change in the occupational structure – far more attention is paid to the effects on wage inequality. This paper has analysed the fortunes of workers displaced from routine occupations.

Using the National Child Development Survey, it looks at occupational transitions between 1981 and 2004. One difficulty simple mobility analysis would face is that it cannot easily distinguish between, on the one hand, career progression and job mismatch explanations of mobility and, on the other hand, the effects of routinisation. Ideally, two separate cohorts would be considered together, where one cohort was not affected by routinisation, whilst the other one was. Assuming everything else remained equal, changes in patterns of mobility and its driving factors across the two cohorts could be seen as evidence of the effects of routinisation. Such a dataset does not exist in UK data. Instead, this paper has presented a new methodology which focuses on transitions within four- or five-year periods and exploits the fact that the degree of routinisation in each period is sufficiently varied and uncorrelated with time that it can be used as a separate explanatory variable.

Table 6: Role of individual-level variables on mobility to select occupational groups following changes to the occupational structure

Occupation	Role of qualifications	Role of age and experience
Professional	More likely with academic level 4-5 qualifications	N/A
Managerial	No role for qualifications	Less likely with greater routine occupational experience and skill specificity, and more likely (in some cases) if older
Intermediate	More likely with academic level 2-3 qualifications and vocational level 4-5 qualifications	More likely when older and less likely (in some cases) with greater routine occupational experience and skill specificity.
Routine (i.e. no mobility)	Less likely with academic level 2-5 qualification and vocational level 4-5 qualifications	Less likely if older, more likely with greater routine occupational experience and skill specificity
Service	No role for qualifications	More likely if older, less likely with greater routine occupational experience and skill specificity

The main result of this analysis is that our measure of routinisation is an important driver of mobility from routine occupations, both upwards to professional and intermediate occupations and downwards to service occupations. Based on unconditional effects estimated without interaction terms, routinisation does not seem to increase the likelihood of moving to a managerial occupation. This relationship is

mediated through several individual-level variables. This paper has estimated marginal and interaction effects for a variety of variables linked to qualifications and working experience. For any given variable, statistical significance depends on the individual's observable characteristics. However, it is possible to summarise the main trends, as in Table 6. In general, these results are supportive of the underlying theoretical model discussed in Section 2.

Table 6 leads to two important conclusions. First, it suggests that not all qualifications have been able to aid displaced routine workers in their future careers. Managerial occupations, in particular, are no more likely an outcome following displacement for a routine worker who holds a degree than a worker who left school at the earliest age. Moreover, higher qualifications do not offer much protection against downward moves – following routinisation, individuals of all educational level are more likely to find themselves in such a job. In addition, there is evidence that vocational qualifications are relatively poor as enablers of upward mobility, and that (for this cohort at least) the attainment of level 3 qualifications of either kind did not significantly increase progression prospects compared to workers with level 2 qualifications.

Second, career experience has important and sometimes conflicting effects on mobility. Specific skills developed through working in routine occupations decrease mobility. When routine jobs are being lost, it is the most experienced routine workers who remain. In addition, individuals are less likely to move from routine occupations to higher wage non-routine occupations as they get older. However, as shown in Table 6, it is older workers who are more likely to move to managerial, intermediate and service occupations as a result of routinisation. This offers a more complex view on the Autor and Dorn notion that routine occupations are 'getting older'. Skill specificity acts to make it less appealing for individuals to leave certain occupations after they have worked in them for a lengthy period of time. Nevertheless, in some cases, routinisation may act as an impetus for older workers to move on to better jobs. This suggests that the role of the two forms of experience identified in the theoretical model may be heterogenous. In some cases, the specific skill effect may dominate, making changing occupation very costly even in the face of declining prospects in the existing occupation. In other cases, general work experience (and the informal training and on-the-job learning it might entail) may lead to significant opportunities

for career advancement (for example, into a managerial role) which the decline in routine occupations may act as the trigger for pursuing.

Illustrative examples were used to give a sense of the magnitude of these effects. In these examples, career mobility led to between 7% and 15% of routine workers moving to new jobs. Up to 8% additional mobility was created for routine workers for a 10% decline in routine occupations, depending on the characteristics of the workers. Mostly, this additional mobility fell between 3% and 7%. Qualifications increased upward mobility, as did labour market experience. Routine experience, on the other hand, made this change in the occupational structure unimportant in terms of total mobility.

What this might mean for a government looking to aid the mobility prospects of these sorts of workers remains an open question. These results suggest that for some transitions, informal learning is potentially just as important as formal qualifications for aiding mobility. This is particularly the case when looking at the growing class of managerial occupations. Moreover, it suggests that those with the most specific skills are less likely to be displaced. This may not be a problem, if such skills are rewarded by employers, even if wages on average are declining in that occupation.

There are a number of directions further research should take. First, the analysis so far has concentrated solely on occupational mobility. A related issue is that of the mobility of wages. The literature on polarisation suggests that there has been a growth in high wage and low wage occupations and a decline in the middle. However, recent work (Holmes 2010, Holmes and Mayhew 2010) finds little evidence of that in the wage distributions, with the middle of the distribution still accounting for the majority of jobs. As we differentiate between the effects of routinisation on occupational and wage distributions, it is also sensible to differentiate between occupational and wage mobility to see whether the job moves captured here translate into the expected change in wages (or other measures of job quality).

Second, as suggested by the model discussed in section 2, there may be differences between the mobility of different cohorts. In this paper, we focus on a single cohort who entered the workforce in the late 1970s, and it is impossible to say yet what these conclusions mean for the labour market as a whole, or what they may mean for future worker mobility. There may be significant differences between the labour market experiences of two generations, one in the labour market when

routinisation began, the other entering during that period. These differences may relate to entry points into the labour market, or changing patterns of lifetime mobility.

Finally, this analysis has suggested that, as well as qualifications, skills and experience, there may be some non-human capital barriers to mobility faced by displaced workers. A government that cares about increasing upward mobility needs to consider helping individuals overcome the barriers that prevent them from moving from their current job to better ones, so identifying such barriers is necessary.

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Appendix 1: Tables A1 – A5

Table A1: Occupational groups using SOC 3-digit categories

MANAGER	PROFESSIONAL	INTERMEDIATE	ROUTINE	NON-ROUTINE MANUAL	SERVICE
Functional managers, Production managers, Protective service officers, Corporate managers and senior officials, Financial institution and office managers, Managers in distribution, storage and retailing.	Business and statistical professionals. Health professionals, Legal professionals, Information and communication technology professionals, Public service professionals, Architects, town planners, surveyors, Science professionals, Engineering professionals, Teaching professionals, Librarians and related professionals, Therapists.	Transport associate professionals, Protective service occupations, Artistic and literary occupations, Business and finance associate professionals, Sales and related associate professionals, Public service and other associate professionals, Social welfare associate professionals, Science and engineering technicians, Sports and fitness occupations, Health associate professionals, Administrative occupations: government and related organizations.	Managers and proprietors in hospitality and leisure services, Managers and proprietors in other service industries, Draughtspersons and building inspectors, Administrative occupations: records, Administrative occupations: communications, Secretarial and related occupations, Electrical trades, Printing trades, Metal machining, fitting and instrument making trades, Metal forming, welding and related trades, Textiles and garments trades, Vehicle trades, Skilled trades nec, Food preparation trades, Construction operatives, Mobile machine drivers and operatives, Plant and machine operatives, Process operatives, Transport drivers and operatives, Assemblers and routine operatives, Elementary administration occupations, Elementary process plant occupations, Elementary construction occupations, Elementary goods storage occupations, Elementary cleaning occupations, Elementary personal services occupations, Elementary agricultural occupations.	Construction trades, Building trades, Agricultural trades.	Design associate professionals, Media associate professionals, Administrative occupations: finance, Leisure and travel service occupations, Sales related occupations, Healthcare and related personal services, Childcare and related personal services, Housekeeping occupations, Sales assistants and retail cashiers, Hairdressers and related occupations, Personal services occupations nec, Customer service occupations, Elementary security occupations, Elementary sales occupations.

Table A2: Change in employment shares by occupational group, 1981-2004

	1981-86	1986-91	1991-95	1995-99	1999-2004	1981-2004
Professional	1.71%	0.83%	0.85%	1.14%	-0.29%	4.24%
Managerial	0.15%	2.15%	1.72%	0.00%	2.43%	6.45%
Intermediate	0.65%	4.40%	0.24%	0.25%	1.95%	7.49%
Routine	-4.30%	-15.29%	-3.27%	-1.90%	-6.27%	-31.04%
Service	1.68%	6.27%	1.38%	0.74%	1.59%	11.66%
Non Routine Manual	0.12%	1.64%	-0.92%	-0.23%	0.59%	1.20%
TOTAL	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Source: LFS, own calculations

Table A3: Results of baseline logit regressions for routine occupation transitions

	PROFESSIONAL		MANAGERIAL		INTERMEDIATE		ROUTINE		SERVICE		MANUAL NON-ROUTINE	
GENDER	-0.020		-0.555	***	0.340	***	-0.532	***	1.948	***	-2.079	***
	-(0.13)		-(4.27)		(3.00)		-(9.21)		(17.01)		-(7.00)	
NON-WHITE	0.292		-0.336		0.305		0.178		-0.633	**	-0.069	
	(0.81)		-(0.92)		(1.18)		(1.14)		-(2.02)		-(0.16)	
PERIOD	-0.204	***	-0.035		-0.126	**	0.051	*	0.011		0.204	***
	-(2.66)		-(0.61)		-(2.34)		(1.92)		(0.28)		(2.62)	
ROUTINE EXP	-0.236	**	-0.328	***	-0.324	***	0.361	***	-0.296	***	-0.485	***
	-(2.44)		-(4.58)		-(4.52)		(10.64)		-(5.65)		-(5.15)	
ROUTINISATION	4.052	***	1.184		1.583	**	-2.691	***	2.867	***	2.144	**
	(4.67)		(1.65)		(2.39)		-(7.85)		(5.22)		(2.00)	
VNVQ LVL0	-0.412	*	-0.209		0.006		0.005		0.333	**	-0.115	
	-(1.80)		-(1.29)		(0.04)		(0.06)		(2.32)		-(0.50)	
ANVQ LVL0	-1.040	***	-0.909	***	-1.088	***	0.333	***	0.268		0.650	
	-(3.10)		-(3.49)		-(4.65)		(2.86)		(1.34)		(1.63)	
VNVQ LVL1	0.435		0.112		-0.006		-0.137		0.228		0.130	
	(1.34)		(0.42)		-(0.02)		-(1.09)		(1.17)		(0.32)	
ANVQ LVL1	-0.871	***	-0.667	***	-0.991	***	0.313	***	0.265		0.445	
	-(2.90)		-(2.77)		-(4.40)		(2.75)		(1.33)		(1.12)	
VNVQ LVL2	-0.012		-0.528	**	-0.041		0.069		0.210		0.006	
	-(0.04)		-(2.18)		-(0.20)		(0.65)		(1.19)		(0.02)	
ANVQ LVL2	-0.638	***	0.073		-0.144		-0.028		0.328	*	0.023	
	-(2.64)		(0.37)		-(0.85)		-(0.28)		(1.81)		(0.06)	
VNVQ LVL4	0.745	***	0.533	***	0.513	**	-0.383	***	-0.042		-1.645	**
	(2.77)		(2.59)		(2.40)		-(3.20)		-(0.16)		-(2.24)	
ANVQ LVL4	1.632	***	0.687	***	0.456	**	-0.881	***	-0.119		-0.549	
	(6.47)		(2.77)		(2.01)		-(6.61)		-(0.42)		-(0.79)	
VNVQ LVL5	0.914	***	0.790	***	0.737	***	-0.832	***	0.073		-0.342	
	(3.33)		(3.35)		(3.10)		-(5.97)		(0.24)		-(0.55)	
ANVQ LVL5	1.991	***	0.320		0.874	*	-1.129	***	0.297		-	
	(4.36)		(0.51)		(1.87)		-(3.68)		(0.46)		-	
CONSTANT	-3.545	***	-2.875	***	-2.889	***	1.897	***	-4.730	***	-4.424	***
	-(11.54)		-(11.68)		-(12.78)		(15.01)		-(19.68)		-(10.06)	

Notes: *** = 1% significance; ** = 5% significance; * = 10% significance. t-statistics given in brackets. Level 5 academic qualifications omitted from non- routine manual regression as it perfectly predicted failure – 56 observations dropped from regression.

Table A4: Results of extended logit regressions for routine occupation transitions with experience interactions

	PROFESSIONAL	MANAGERIAL	INTERMEDIATE	ROUTINE	SERVICE	MANUAL NON-ROUTINE
GENDER	-0.016 (-0.10)	-0.548*** (-4.22)	0.350*** (3.09)	-0.545*** (-9.38)	1.953*** (17.05)	-2.067*** (-6.97)
NON-WHITE	0.287 (0.79)	-0.324 (-0.89)	0.311 (1.20)	0.180 (1.15)	-0.656** (-2.09)	-0.050 (-0.12)
PERIOD	-0.439** (-2.14)	-0.396*** (-2.76)	-0.474*** (-3.46)	0.415*** (6.14)	-0.315*** (-3.09)	-0.031 (-0.16)
ROUTINE EXP	1.201 (1.28)	-1.774** (-2.35)	0.023 (0.03)	0.476 (1.36)	0.046 (0.08)	-1.976 (-1.53)
ROUTINISATION	3.395 (0.91)	-4.859* (-1.64)	-4.644* (-1.66)	0.395 (0.28)	1.285 (0.62)	-1.329 (-0.30)
PERIOD*ROUTINE EXP	-0.334 (-1.24)	0.464** (2.29)	-0.105 (-0.50)	-0.089 (-0.91)	-0.035 (-0.22)	0.330 (0.93)
PERIOD*ROUTINISATION	1.426 (0.80)	3.213** (2.52)	3.093** (2.52)	-2.579*** (-4.25)	1.989** (2.23)	1.455 (0.83)
ROUTINE EXP * ROUTINISATION	-11.513** (-2.25)	6.461 (1.55)	-3.282 (-0.80)	4.715** (2.37)	-8.824*** (-2.72)	3.357 (0.48)
ROUTINE EXP *PERIOD* ROUTINISATION	2.712* (1.69)	-2.527** (-2.11)	0.970 (0.77)	-0.611 (-1.05)	1.697* (1.78)	-0.652 (-0.32)
VNVQ LVL0	-0.430* (-1.87)	-0.194 (-1.20)	0.026 (0.16)	-0.011 (-0.13)	0.341** (2.36)	-0.076 (-0.33)
ANVQ LVL0	-1.047*** (-3.13)	-0.896*** (-3.44)	-1.091*** (-4.66)	0.333*** (2.84)	0.269 (1.34)	0.659* (1.65)
VNVQ LVL1	0.376 (1.16)	0.063 (0.23)	-0.082 (-0.31)	-0.053 (-0.42)	0.175 (0.89)	-0.066 (-0.16)
ANVQ LVL1	-0.876*** (-2.91)	-0.651*** (-2.70)	-0.986*** (-4.38)	0.307*** (2.67)	0.265 (1.32)	0.473 (1.19)
VNVQ LVL2	-0.020 (-0.07)	-0.520** (-2.15)	-0.037 (-0.18)	0.068 (0.64)	0.205 (1.16)	0.021 (0.07)
ANVQ LVL2	-0.645*** (-2.67)	0.087 (0.45)	-0.140 (-0.82)	-0.036 (-0.35)	0.332* (1.83)	0.043 (0.11)
VNVQ LVL4	0.720*** (2.68)	0.538** (2.61)	0.508*** (2.37)	-0.373*** (-3.09)	-0.078 (-0.30)	-1.635** (-2.23)
ANVQ LVL4	1.565*** (6.17)	0.678*** (2.72)	0.431* (1.90)	-0.833*** (-6.17)	-0.214 (-0.75)	-0.564 (-0.81)
VNVQ LVL5	0.883*** (3.19)	0.806*** (3.40)	0.756*** (3.17)	-0.853*** (-6.03)	0.052 (0.17)	-0.308 (-0.49)
ANVQ LVL5	1.895*** (4.11)	0.306 (0.48)	0.863* (1.83)	-1.063*** (-3.38)	0.132 (0.20)	- -
CONSTANT	-3.232*** (-7.12)	-2.221*** (-6.36)	-2.197*** (-6.83)	1.306*** (7.53)	-4.206*** (-14.11)	-3.814*** (-6.70)

Notes: *** = 1% significance; ** = 5% significance; * = 10% significance. t-statistics given in brackets. Level 5 academic qualifications omitted from non- routine manual regression as it perfectly predicted failure – 56 observations dropped from regression.

Table A5: Results of extended logit regressions for routine occupation transitions with qualification interactions

	PROFESSIONAL		MANAGERIAL		INTERMEDIATE		ROUTINE		SERVICE		MANUAL NON-ROUTINE	
GENDER	-0.011		-0.560	***	0.324	***	-0.527	***	1.961	***	-2.075	***
	(-0.07)		(-4.37)		(2.88)		(-9.20)		(17.19)		(-7.02)	
NON-WHITE	0.274		-0.318		0.335		0.179		-0.684	**	-0.047	
	(0.75)		(-0.87)		(1.30)		(1.14)		(-2.19)		(-0.11)	
PERIOD	-0.178	**	-0.039		-0.137	**	0.053	**	0.012		0.226	***
	(-2.35)		(-0.70)		(-2.56)		(2.02)		(0.30)		(2.97)	
ROUTINE EXP	-0.238	**	-0.330	***	-0.328	***	0.360	***	-0.299	***	-0.489	***
	(-2.48)		(-4.60)		(-4.57)		(10.63)		(-5.72)		(-5.18)	
ROUTINISATION	0.678		1.617		-1.761		-1.871	***	3.379	***	1.878	
	(0.32)		(1.08)		(-1.04)		(-3.21)		(4.06)		(1.39)	
ACADEMIC LVL 2-3	-0.059		0.877	***	0.606	**	-0.287	**	0.118		-0.573	*
	(-0.15)		(3.31)		(2.45)		(-2.57)		(0.70)		(-1.67)	
ACADEMIC LVL 4-5	1.837	***	2.089	***	1.505	***	-0.868	***	-0.778		0.774	
	(4.09)		(4.85)		(3.94)		(-3.94)		(-1.50)		(0.38)	
VOC LVL 4-5	0.641		3.300	*	1.582	**	-0.865	**	0.677		-1.454	
	(0.64)		(1.77)		(2.11)		(-2.15)		(0.79)		(-1.00)	
ROUTINISATION * ACADEMIC LVL 2-3	4.142		0.433		3.717	*	-0.991		-1.036		1.254	
	(1.57)		(0.24)		(1.94)		(-1.29)		(-0.91)		(0.56)	
ROUTINISATION * ACADEMIC LVL 4-5	7.590	***	-5.658		2.646		-3.140	**	2.540		-27.226	
	(2.68)		(-1.60)		(0.96)		(-2.09)		(0.85)		(-0.82)	
ROUTINISATION * VOC LVL 4-5	4.009		-38.478		-5.622		5.394		-8.404		4.869	
	(0.63)		(-1.23)		(-0.71)		(1.50)		(-0.95)		(0.56)	
ACADEMIC LVL 2-3 * VOC LVL 4-5	1.121		-2.449		-1.516	*	0.493		-0.851		0.797	
	(1.03)		(-1.30)		(-1.85)		(1.11)		(-0.90)		(0.41)	
ACADEMIC LVL 4-5 * VOC LVL 4-5	0.526		-3.089		-1.840	*	0.230		-0.179		1.019	
	(0.47)		(-1.59)		(-1.89)		(0.42)		(-0.14)		(0.31)	
ROUTINISATION * ACADEMIC LVL 2-3 * VOC LVL 4-5	-6.558		37.771		9.554		-6.542	*	6.832		-11.504	
	(-0.95)		(1.20)		(1.17)		(-1.73)		(0.74)		(-0.84)	
ROUTINISATION * ACADEMIC LVL 4-5 * VOC LVL 4-5	-8.512		44.568		8.828		-5.775		4.848		2.670	
	(-1.20)		(1.41)		(1.00)		(-1.32)		(0.45)		(0.06)	
CONSTANT	-4.389	***	-3.906	***	-3.593	***	2.141	***	-4.265	***	-4.008	***
	(-13.15)		(-15.73)		(-15.18)		(20.54)		(-23.74)		(-14.79)	

Notes: *** = 1% significance; ** = 5% significance; * = 10% significance. t-statistics given in brackets.

Appendix 2: Figures A1.1 – A4.5, Experience and routinisation marginal and interaction effects

Destination: routine occupations

Figure A1.1: (i) Marginal effects of age (PERIOD); (ii) t-statistics of marginal effects

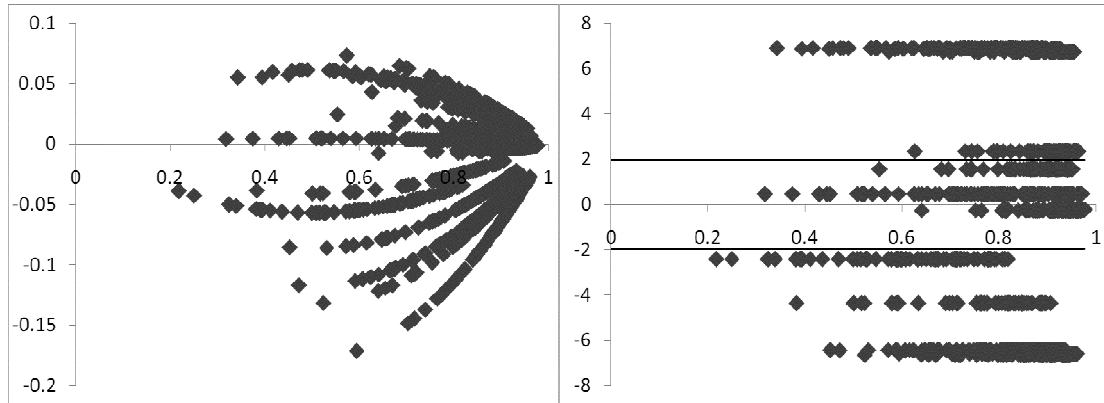
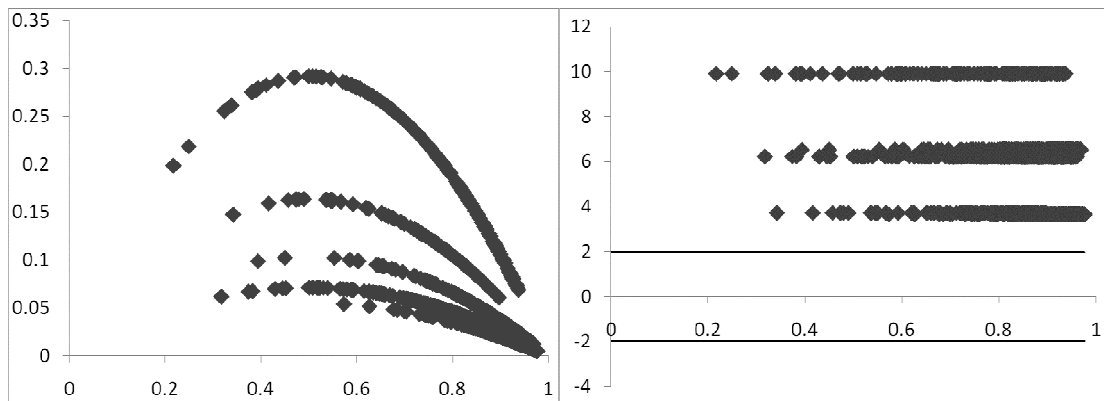


Figure A1.2: (i) Marginal effects of specific experience (SPECIFIC); (ii) t-statistics of marginal effects



FigureA1.3: (i) Marginal effects of routinisation;(ii) t-statistics of marginal effects

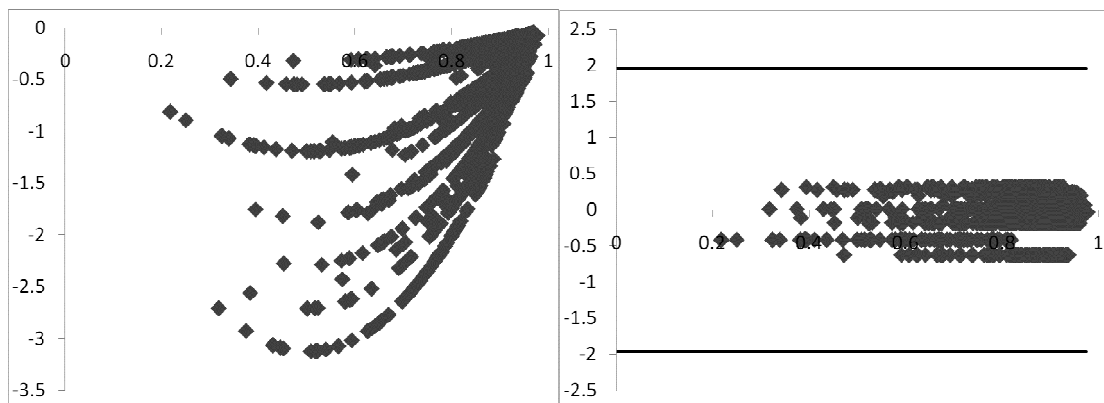


Figure A1.4: (i) Interaction effects of age and routinisation; (ii) t-statistics of interaction effects

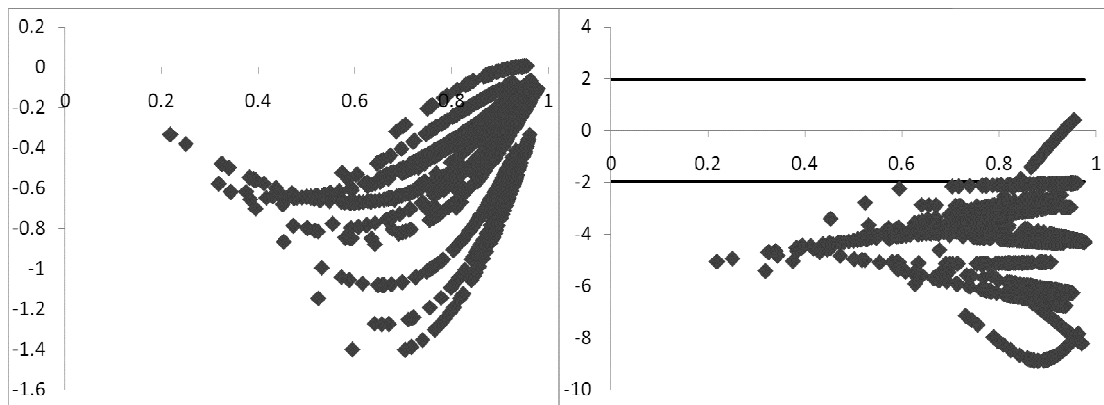
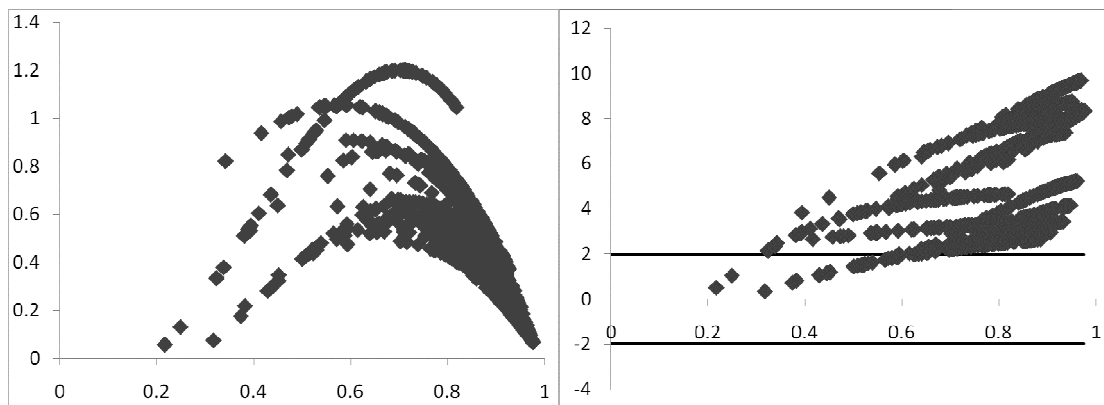


Figure A1.5: (i) Interaction effects of specific experience and routinisation; (ii) t-statistics of interaction effects



Destination: managerial occupations

Figure A2.1: (i) Marginal effects of age (PERIOD); (ii) t-statistics of marginal effects

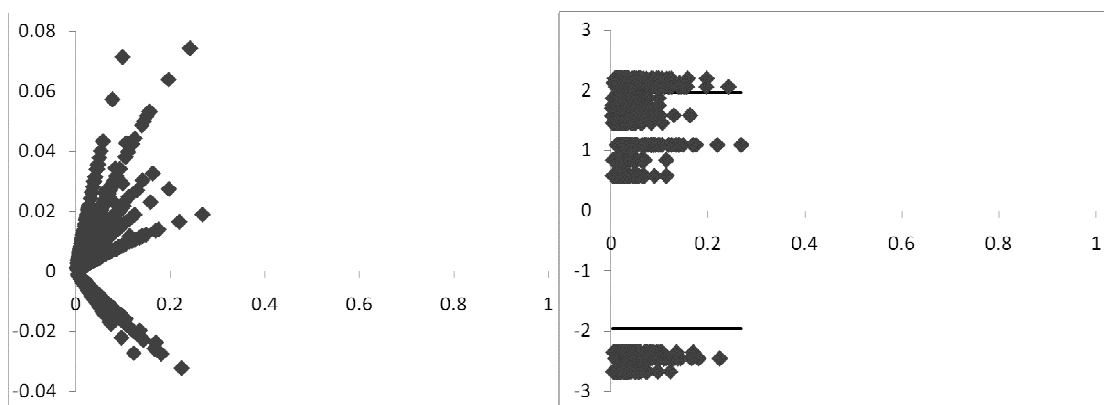


Figure A2.2: (i) Marginal effects of specific experience (SPECIFIC); (ii) t-statistics of marginal effects

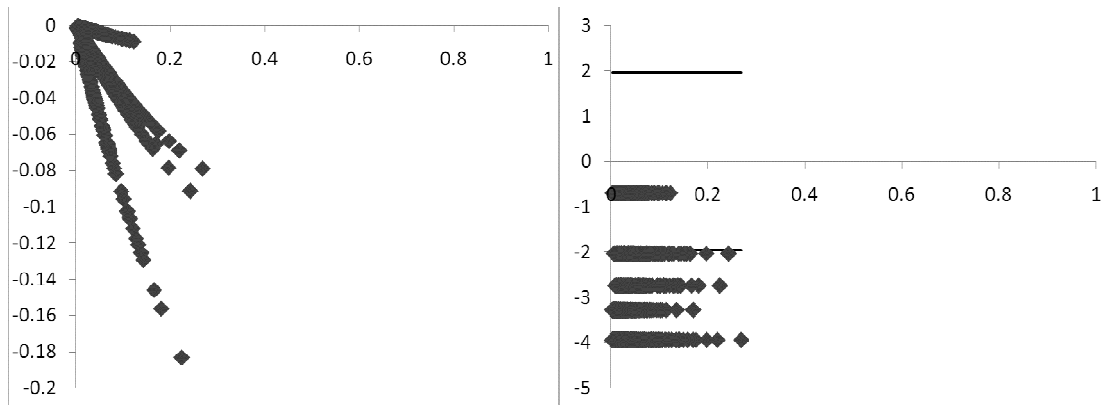


Figure A2.3: (i) Marginal effects of routinisation; (ii) t-statistics of marginal effects

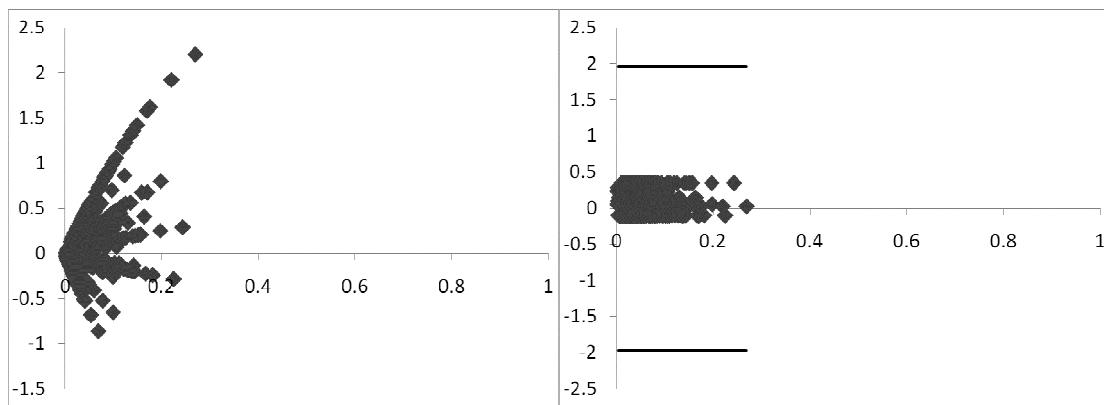


Figure A2.4: (i) Interaction effects of age and routinisation; (ii) t-statistics of interaction effects

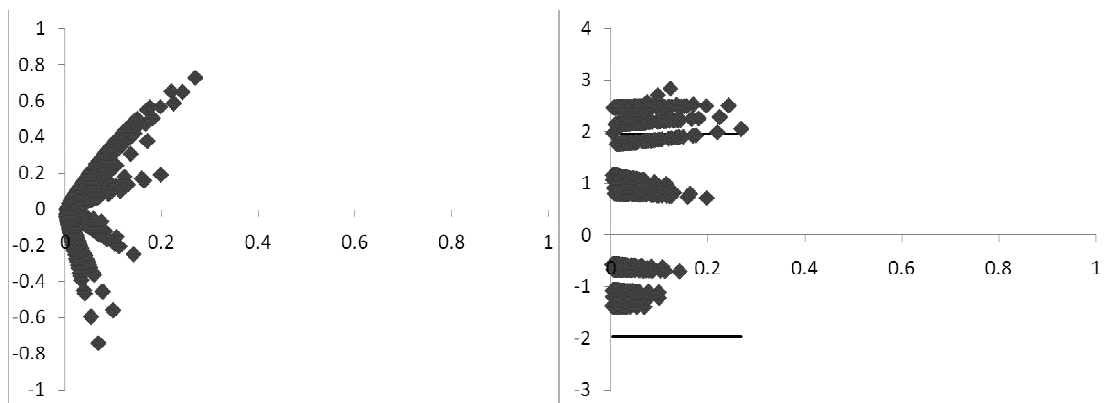
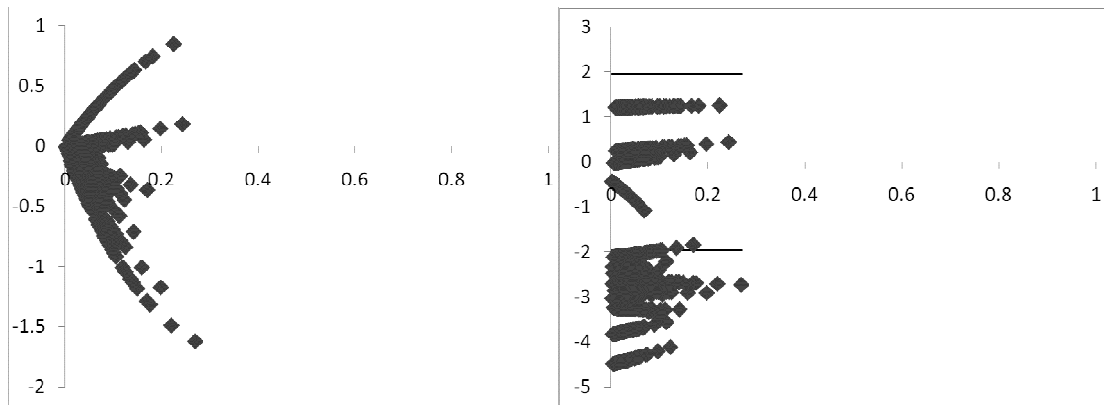


Figure A2.5: (i) Interaction effects of specific experience and routinisation;(ii) t-statistics of interaction effects



Destination: intermediate occupations

Figure A3.1: (i) Marginal effects of age (PERIOD); (ii) t-statistics of marginal effects

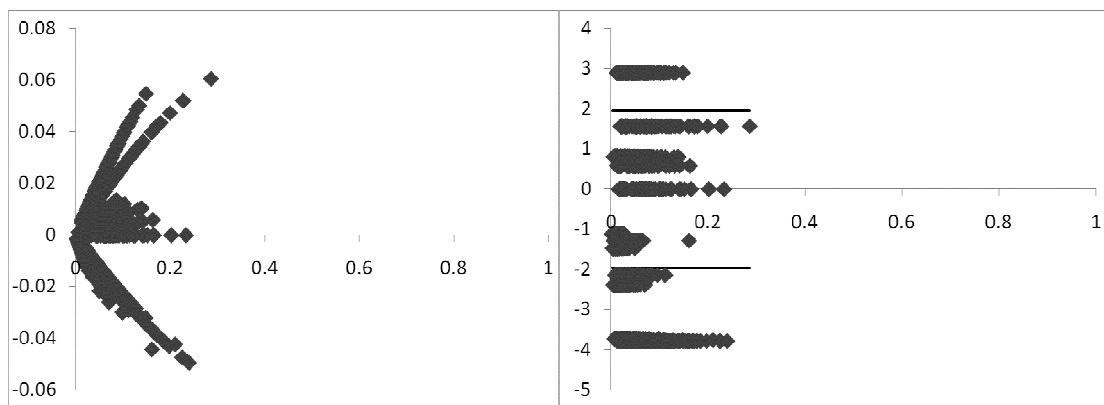


Figure A3.2: (i) Marginal effects of specific experience (SPECIFIC); (ii) t-statistics of marginal effects

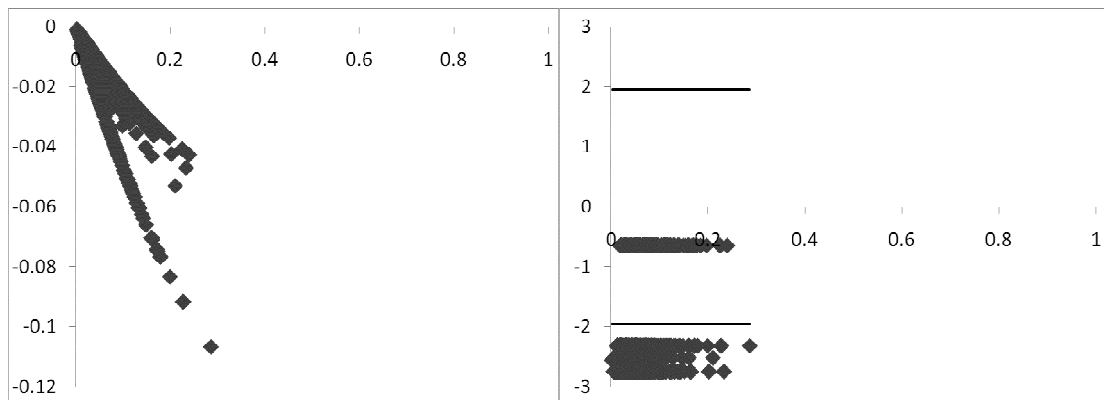


Figure A3.3: (i) Marginal effects of routinisation; (ii) t-statistics of marginal effects

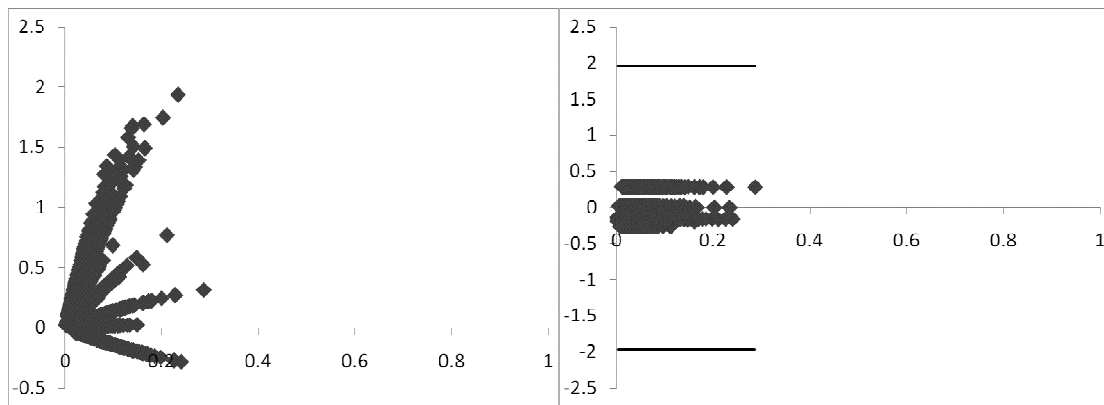


Figure A3.4: (i) Interaction effects of age and routinisation; (ii) t-statistics of interaction effects

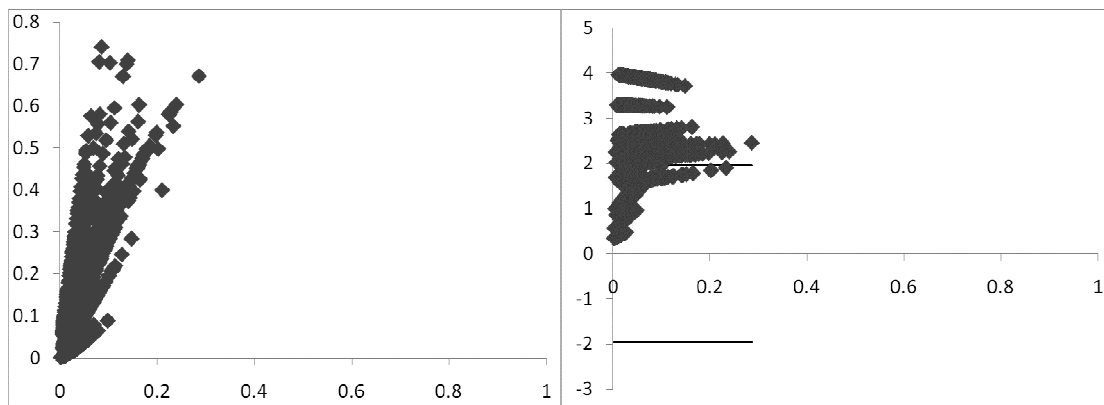
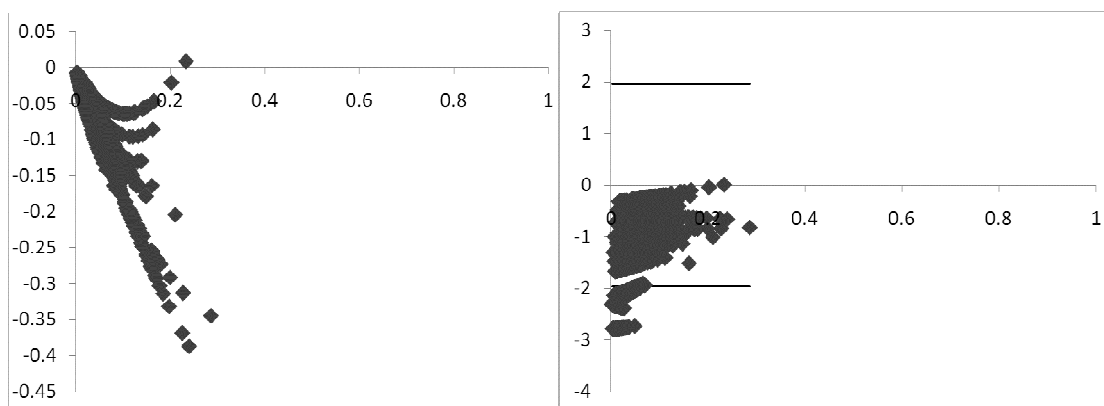


Figure A3.5: (i) Interaction effects of specific experience and routinisation; (ii) t-statistics of interaction effects



Destination: service occupations

Figure A4.1: (i) Marginal effects of age (PERIOD); (ii) t-statistics of marginal effects

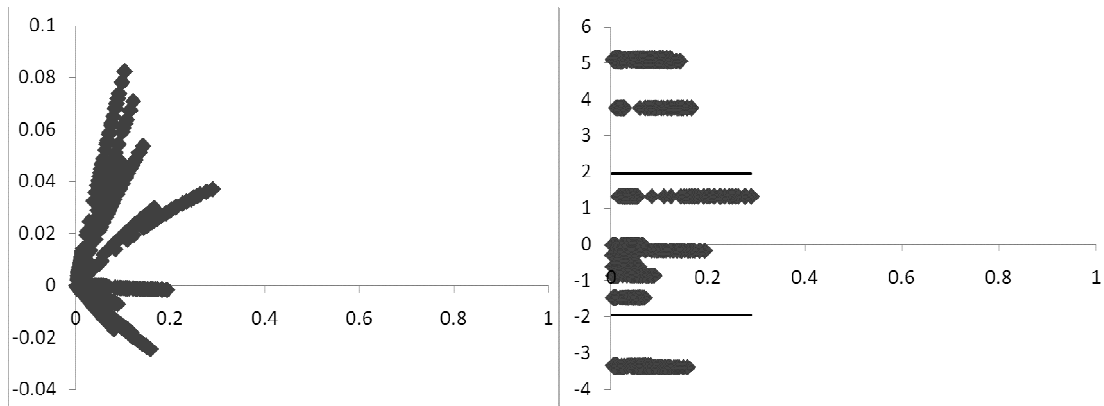


Figure A4.2: (i) Marginal effects of specific experience (SPECIFIC); (ii) t-statistics of marginal effects

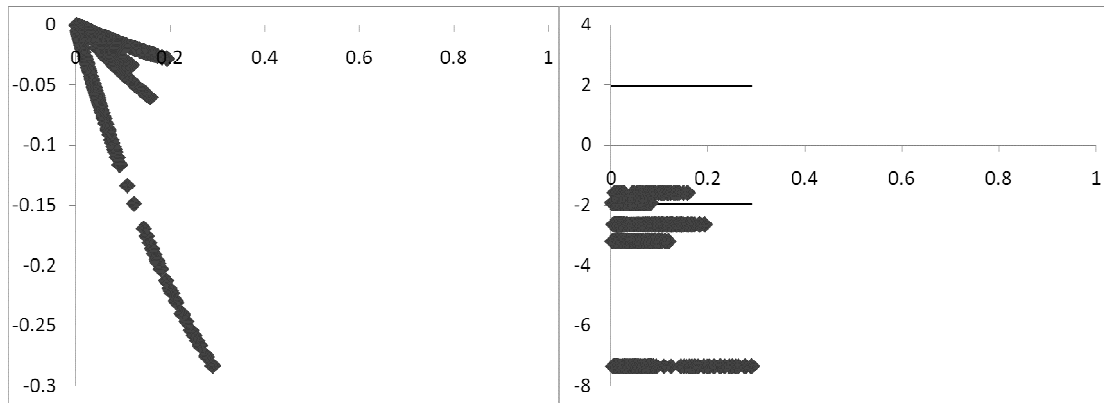


Figure A4.3: (i) Marginal effects of routinisation; (ii) t-statistics of marginal effects

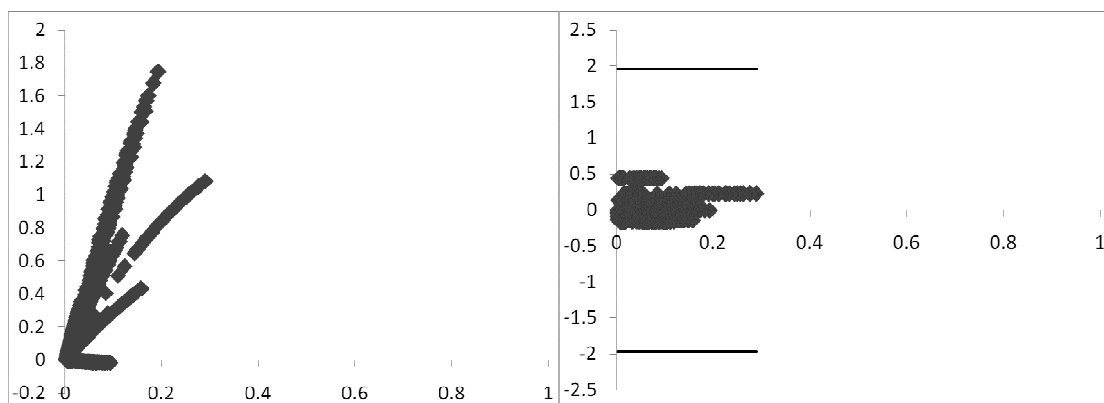


Figure A4.4: (i) Interaction effects of age and routinisation; (ii) t-statistics of interaction effects

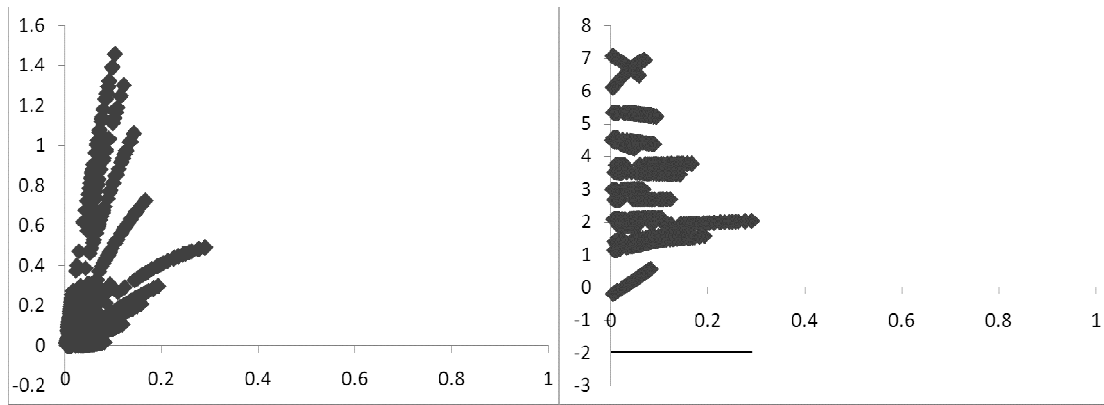
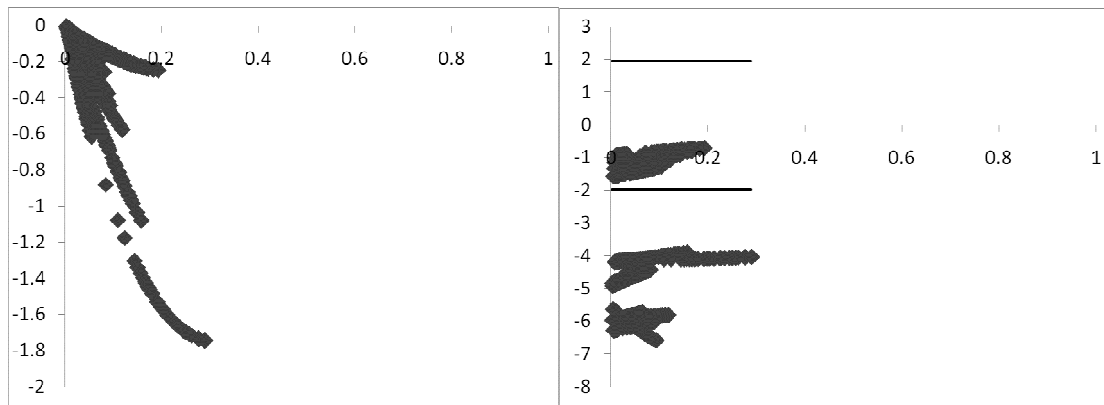


Figure A4.5: (i) Interaction effects of specific experience and routinisation; (ii) t-statistics of interaction effects



Appendix 3: Figures A5.1 – A9.7, Qualifications and routinisation marginal and interaction effects

Destination: routine occupations

Figure A5.1: (i) Marginal effects of academic qualification level 2-3; (ii) t-statistics of marginal effects

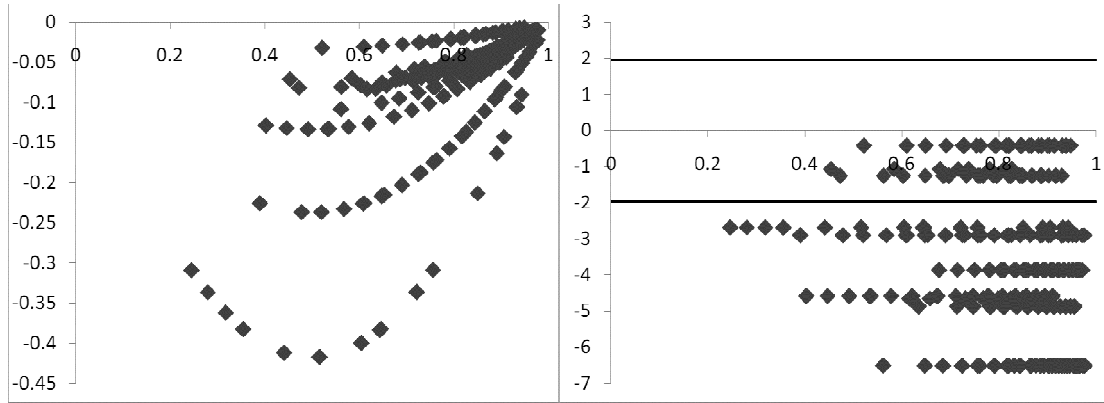


Figure A5.2: (i) Marginal effects of academic qualification level 4-5; (ii) t-statistics of marginal effects

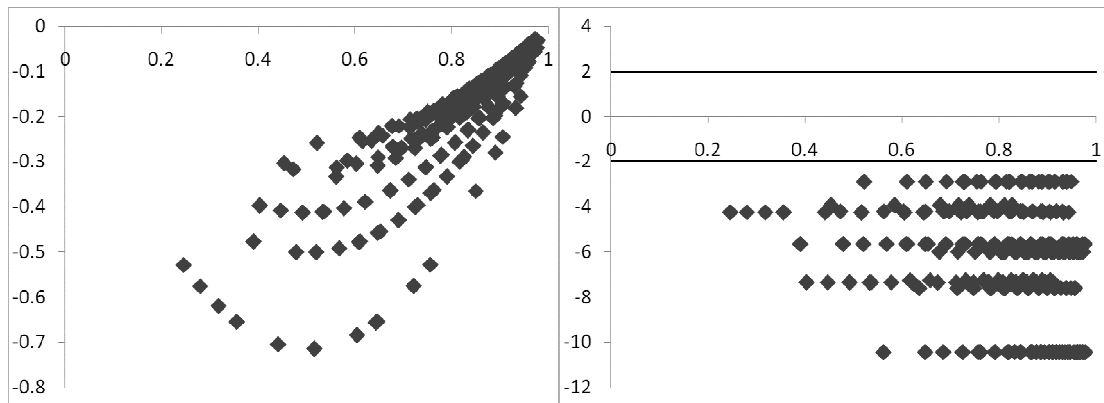


Figure A5.3: (i) Marginal effects of vocational qualification level 4-5; (ii) t-statistics of marginal effects

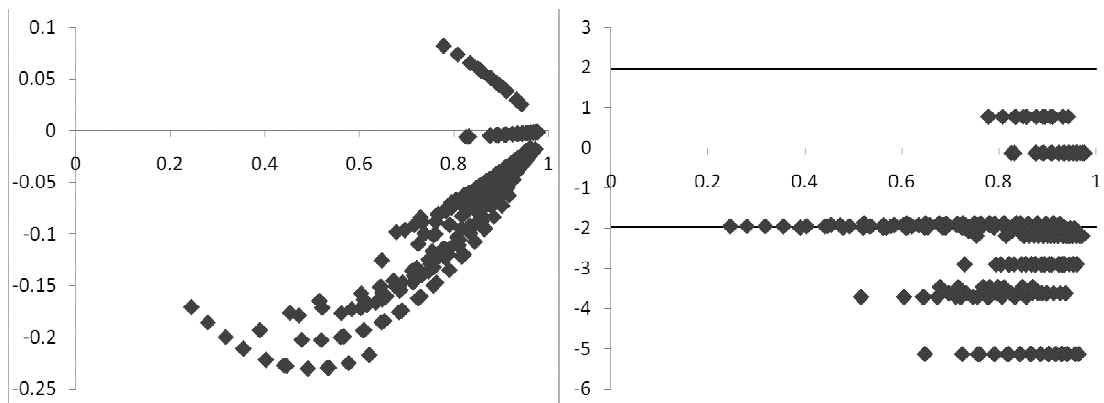


Figure A5.4: (i) Marginal effects of routinisation; (ii) t-statistics of marginal effects

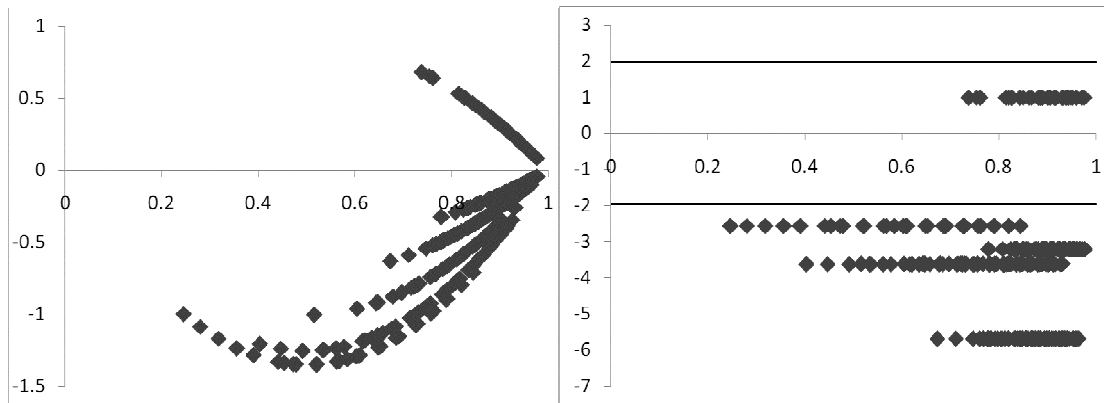


Figure A5.5: (i) Interaction effects of academic qualification level 2-3 and routinisation; (ii) t-statistics of interaction effects

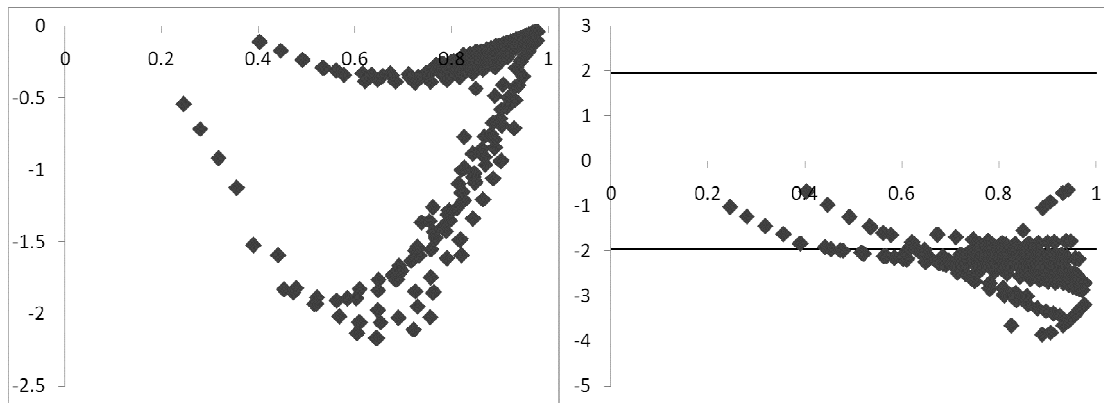


Figure A5.6: (i) Interaction effects of academic qualification level 4-5 and routinisation; (ii) t-statistics of interaction effects

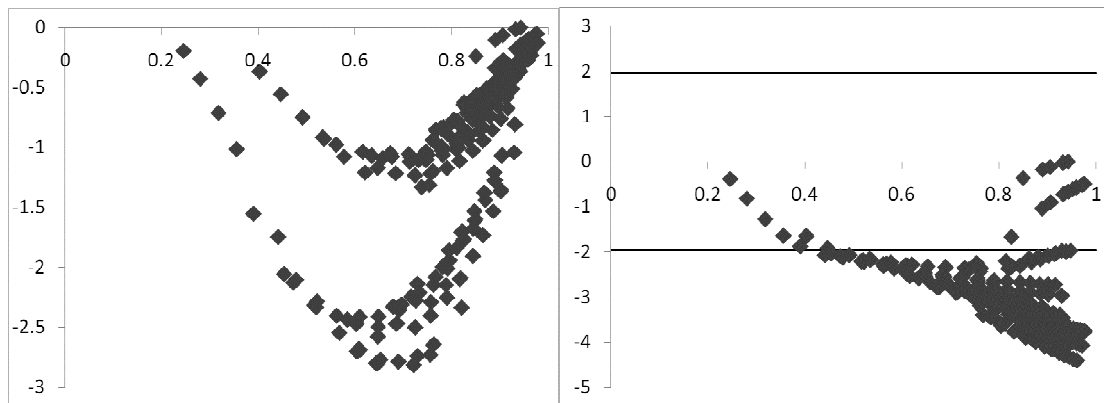
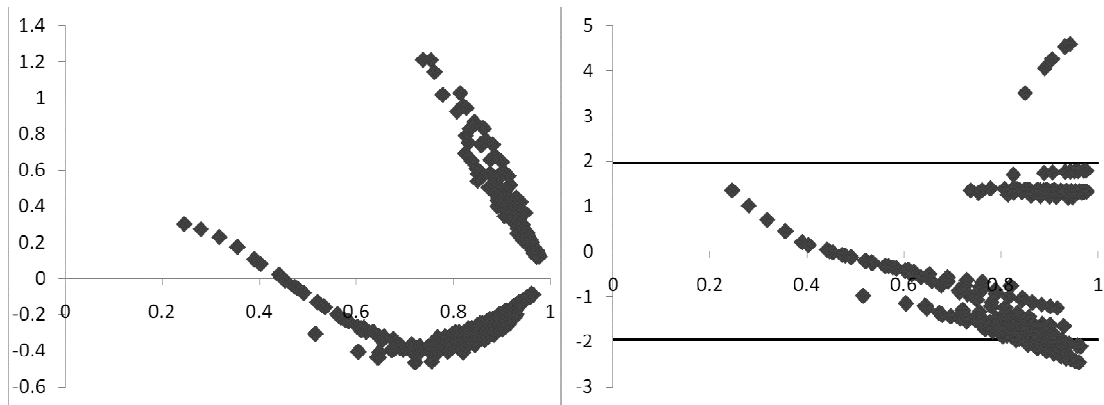


Figure A5.7: (i) Interaction effects of vocational qualification level 4-5 and routinisation; (ii) t-statistics of interaction effects



Destination: professional occupation

Figure A6.1: (i) Marginal effects of academic qualification level 2-3; (ii) t-statistics of marginal effects

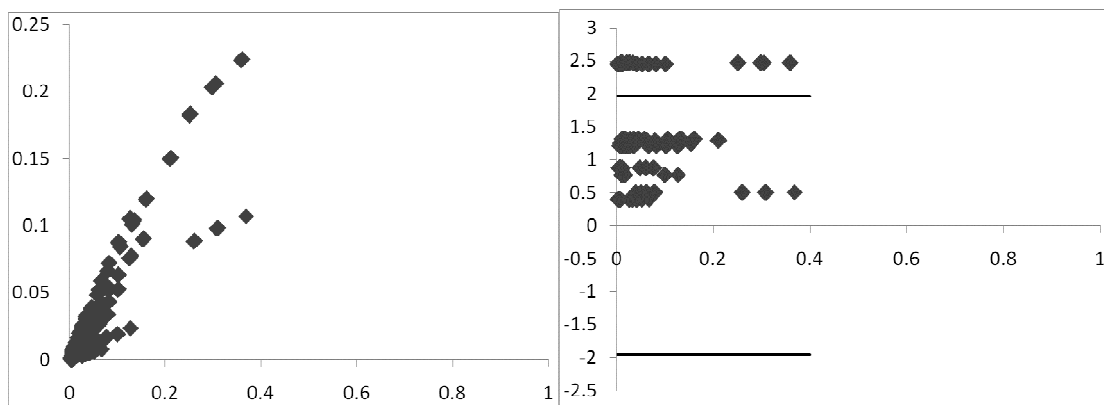


Figure A6.2: (i) Marginal effects of academic qualification level 4-5; (ii) t-statistics of marginal effects

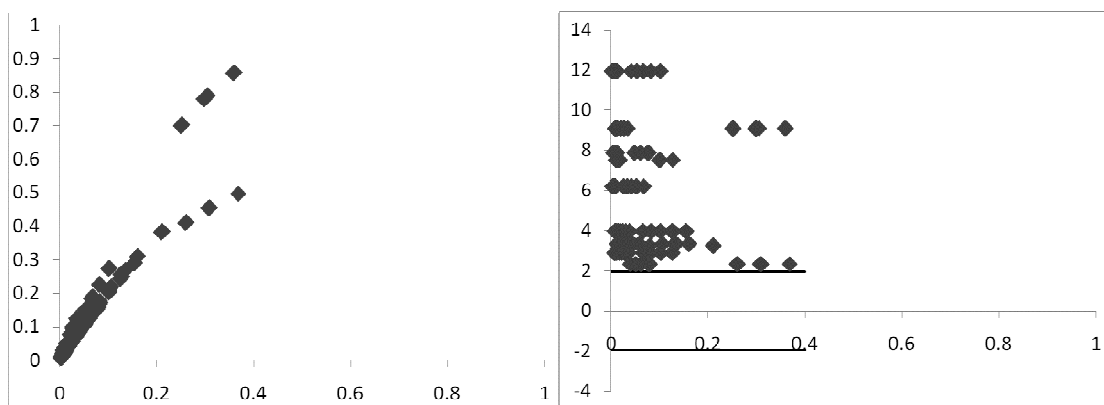


Figure A6.3: (i) Marginal effects of vocational qualification level 4-5; (ii) t-statistics of marginal effects

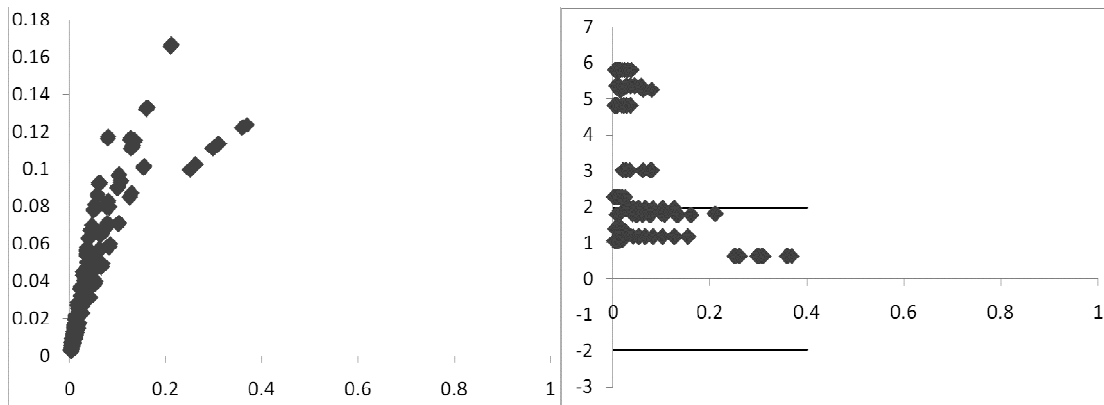


Figure A6.4: (i) Marginal effects of routinisation; (ii) t-statistics of marginal effects

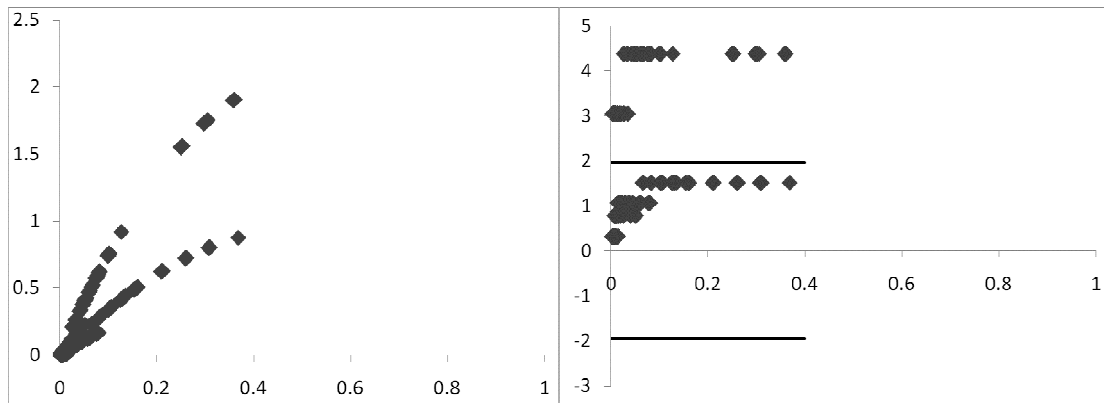


Figure A6.5: (i) Interaction effects of academic qualification level 2-3 and routinisation; (ii) t-statistics of interaction effects

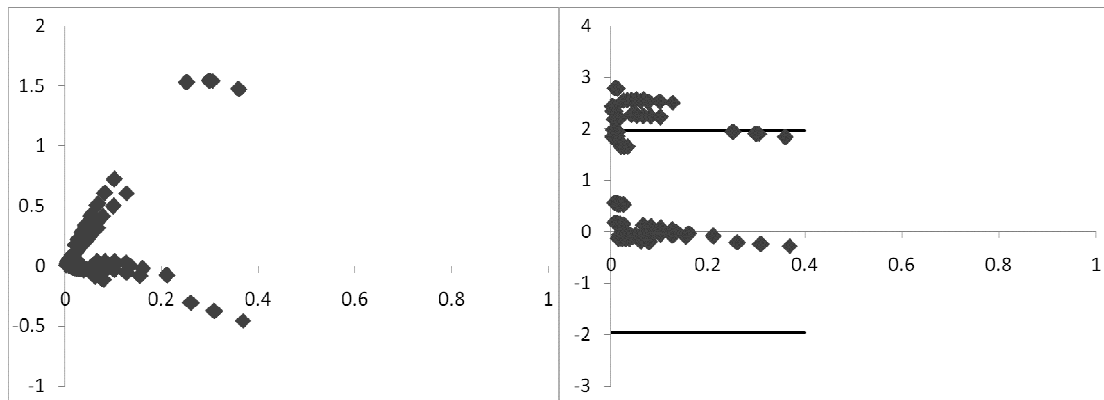


Figure A6.6: (i) Interaction effects of academic qualification level 4-5 and routinisation; (ii) t-statistics of interaction effects

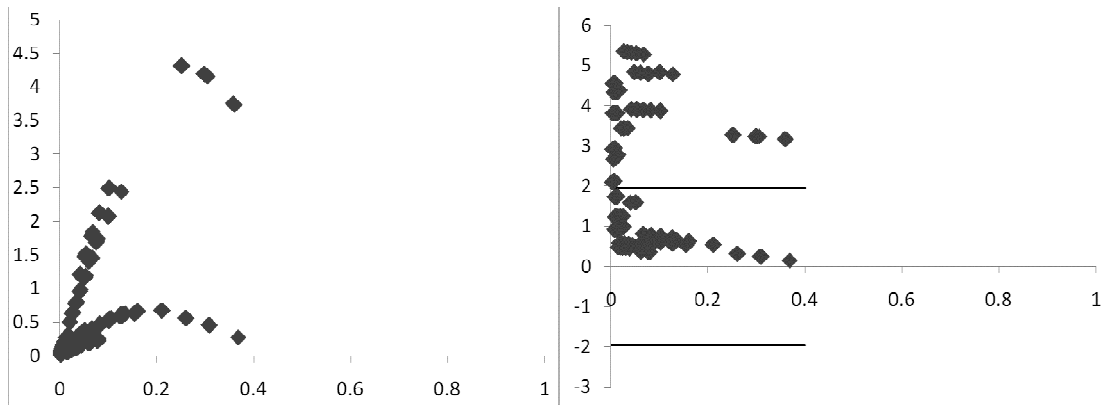
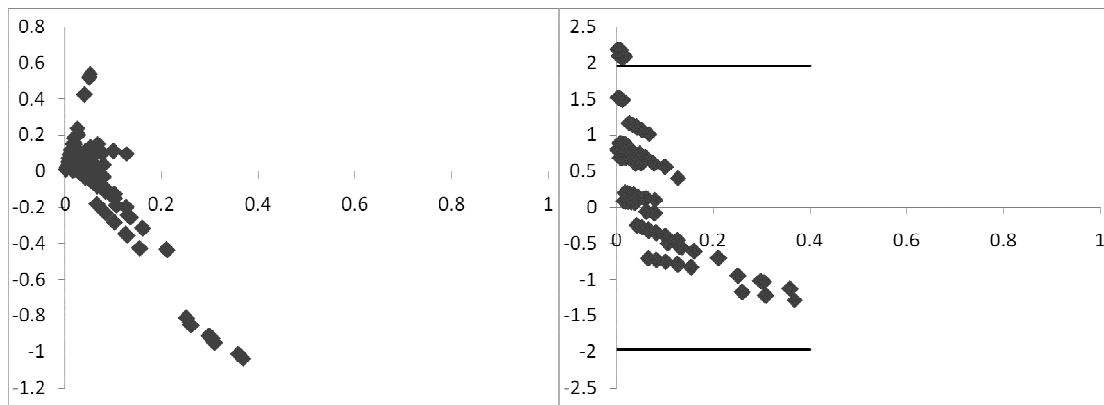


Figure A6.7: (i) Interaction effects of vocational qualification level 4-5 and routinisation; (ii) t-statistics of interaction effects



Destination: managerial occupations

Figure A7.1: (i) Marginal effects of academic qualification level 2-3; (ii) t-statistics of marginal effects

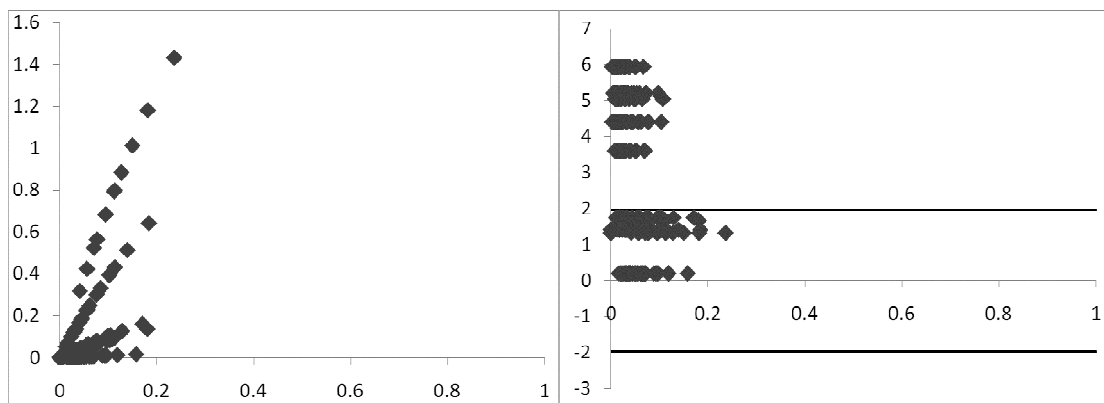


Figure A7.2: (i) Marginal effects of academic qualification level 4-5; (ii) t-statistics of marginal effects

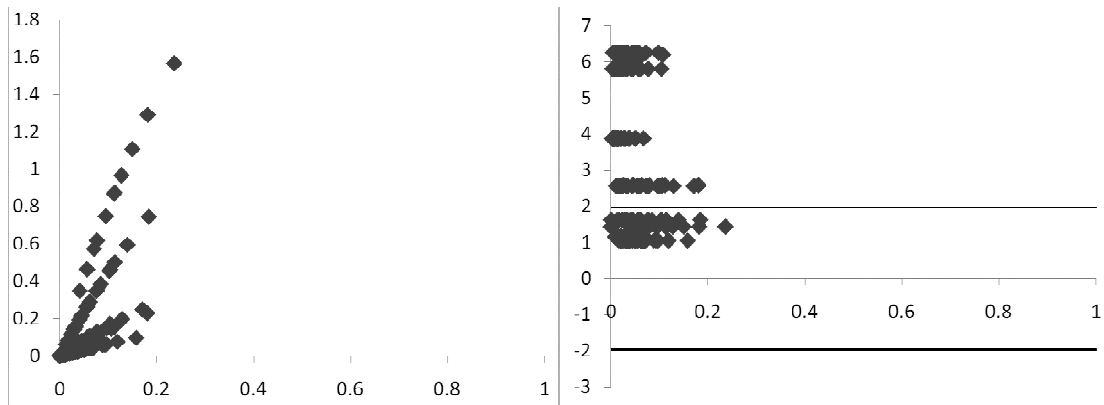


Figure A7.3: (i) Marginal effects of vocational qualification level 4-5; (ii) t-statistics of marginal effects

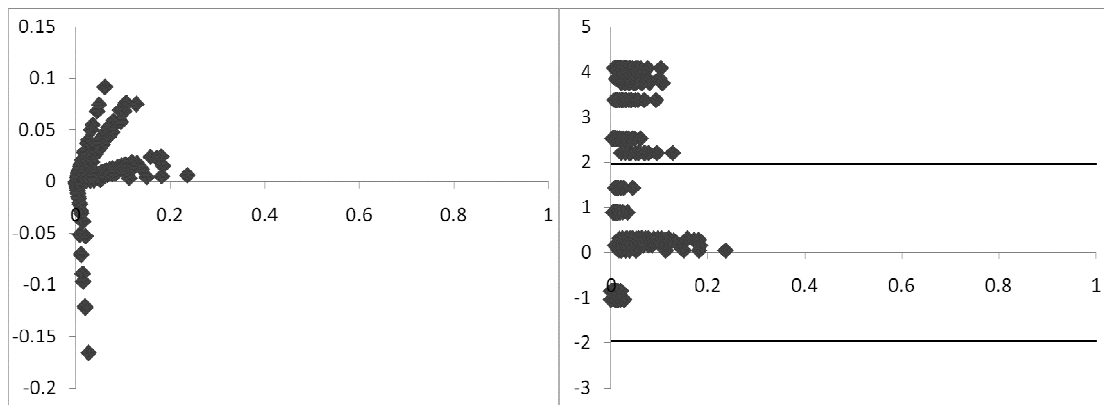


Figure A7.4: (i) Marginal effects of routinisation; (ii) t-statistics of marginal effects

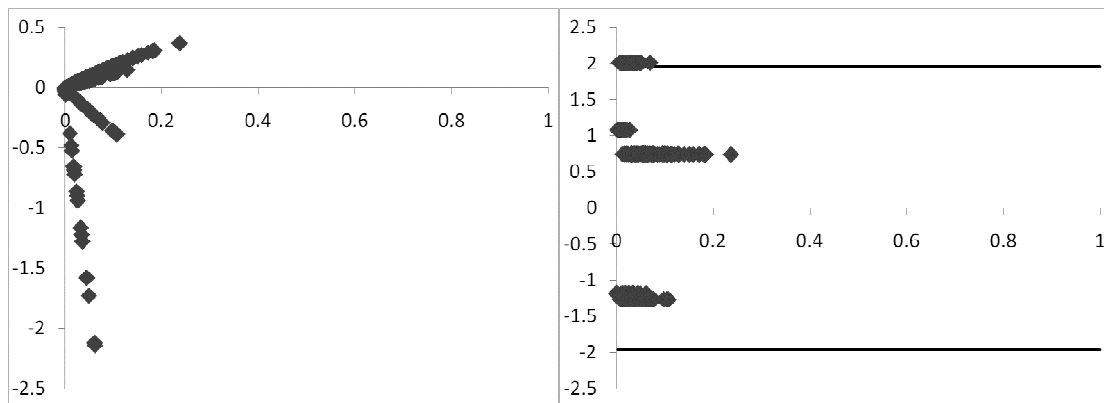


Figure A7.5: (i) Interaction effects of academic qualification level 2-3 and routinisation; (ii) t-statistics of interaction effects

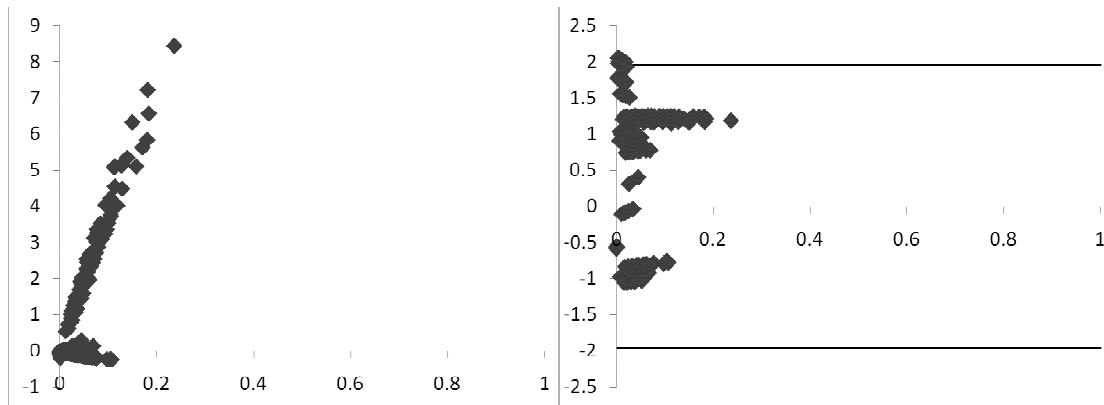


Figure A7.6: (i) Interaction effects of academic qualification level 4-5 and routinisation; (ii) t-statistics of interaction effects

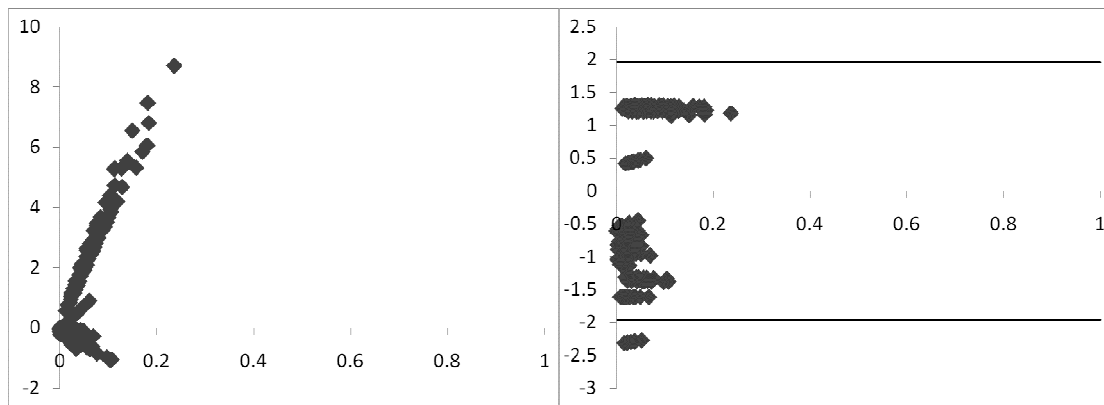
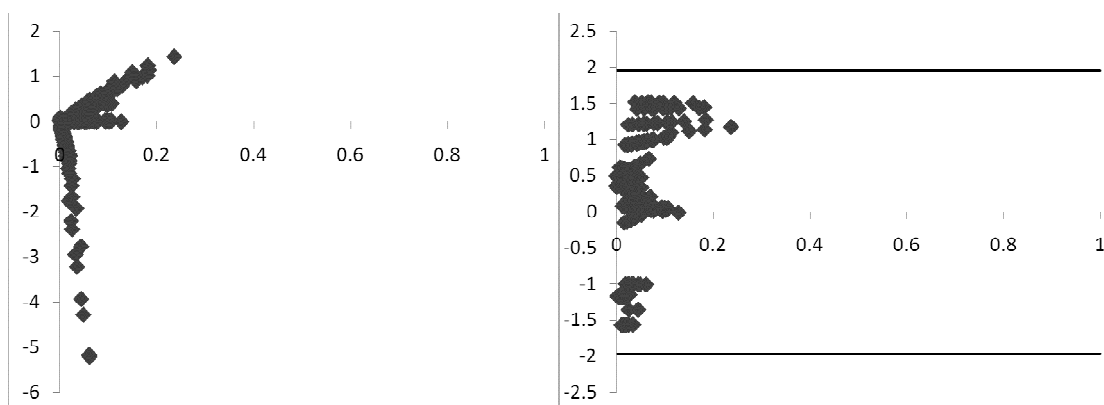


Figure A7.7: (i) Interaction effects of vocational qualification level 4-5 and routinisation; (ii) t-statistics of interaction effects



Destination: intermediate occupations

Figure A8.1: (i) Marginal effects of academic qualification level 2-3; (ii) t-statistics of marginal effects

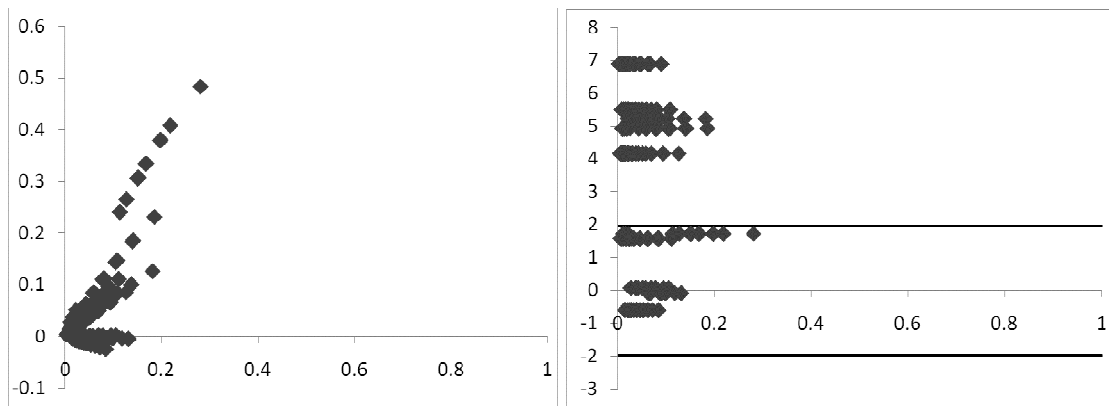


Figure A8.2: (i) Marginal effects of academic qualification level 4-5; (ii) t-statistics of marginal effects

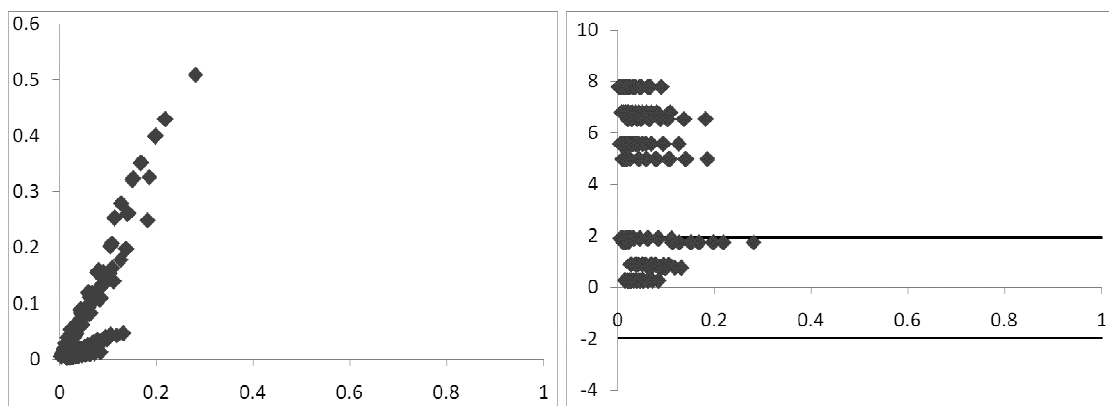


Figure A8.3: (i) Marginal effects of vocational qualification level 4-5; (ii) t-statistics of marginal effects

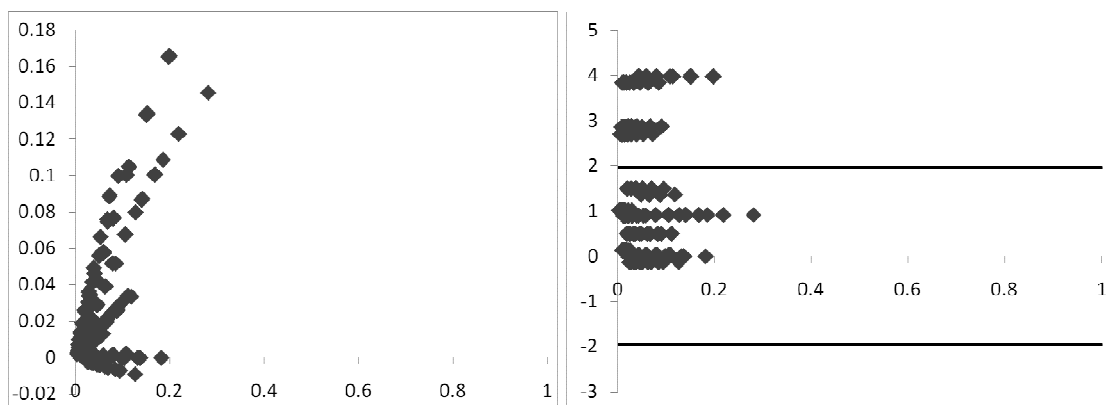


Figure A8.4: (i) Marginal effects of routinisation; (ii) t-statistics of marginal effects

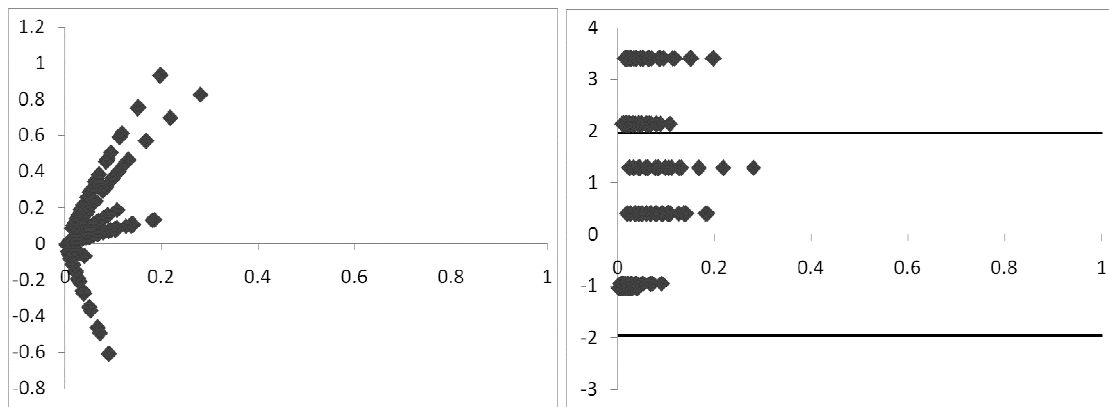


Figure A8.5: (i) Interaction effects of academic qualification level 2-3 and routinisation; (ii) t-statistics of interaction effects

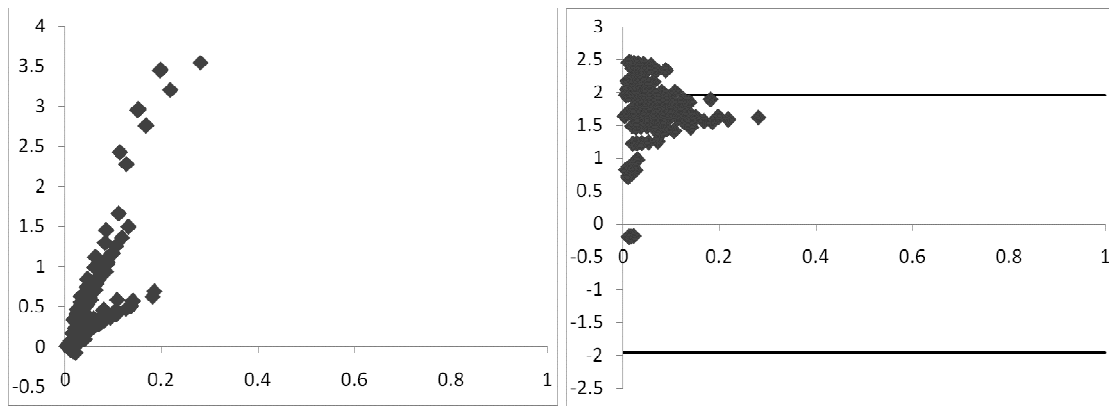


Figure A8.6: (i) Interaction effects of academic qualification level 4-5 and routinisation; (ii) t-statistics of interaction effects

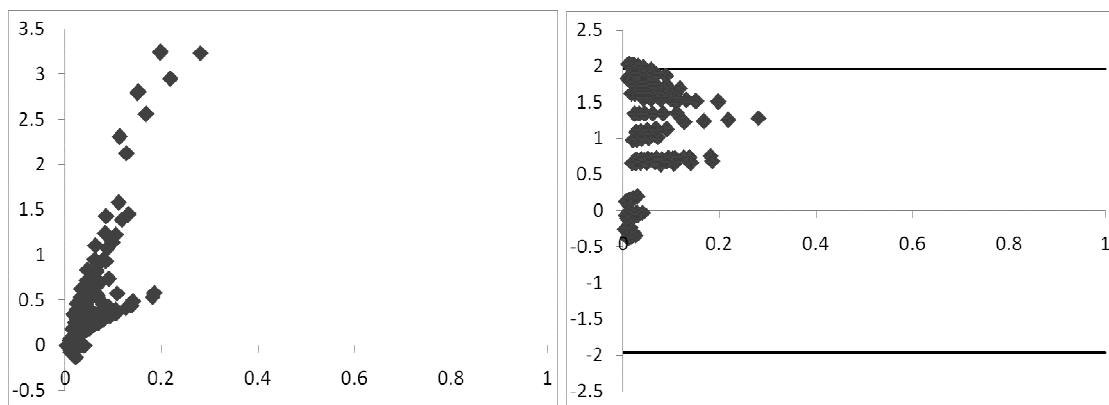
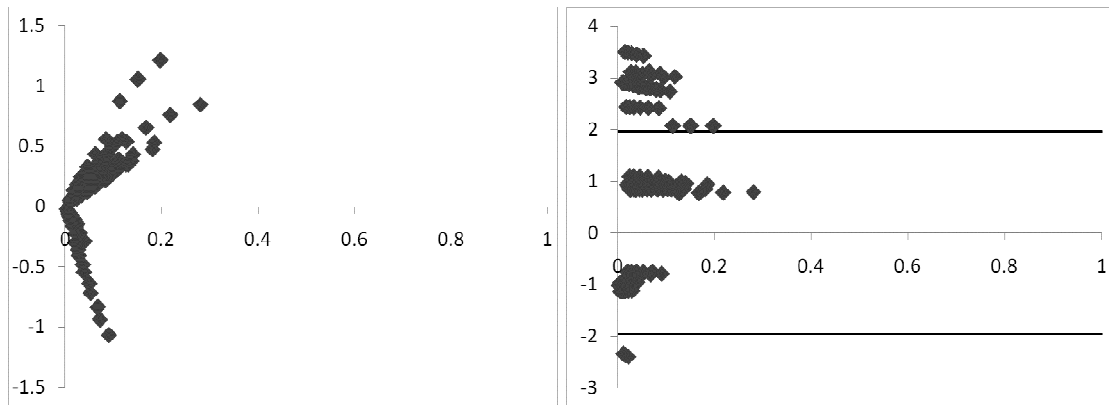


Figure A8.7: (i) Interaction effects of vocational qualification level 4-5 and routinisation; (ii) t-statistics of interaction effects



Destination: service occupations

Figure A9.1: (i) Marginal effects of academic qualification level 2-3; (ii) t-statistics of marginal effects

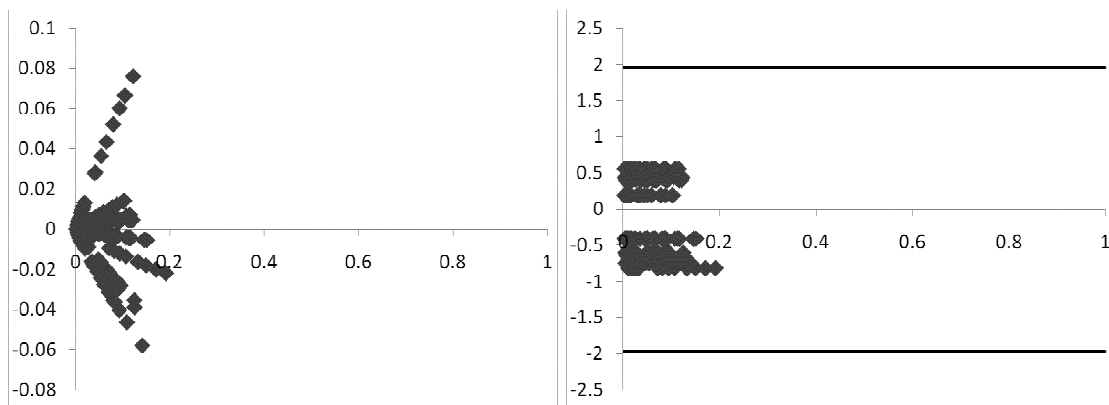


Figure A9.2: (i) Marginal effects of academic qualification level 4-5; (ii) t-statistics of marginal effects

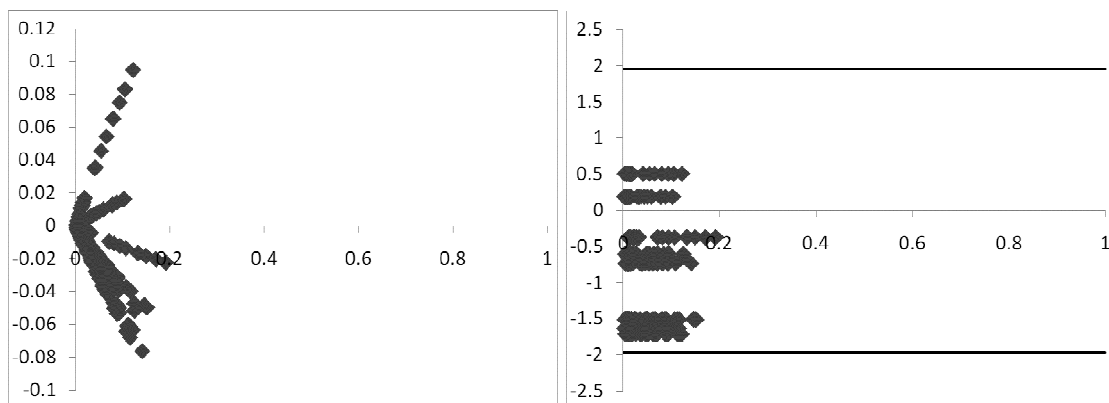


Figure A9.3: (i) Marginal effects of vocational qualification level 4-5; (ii) t-statistics of marginal effects

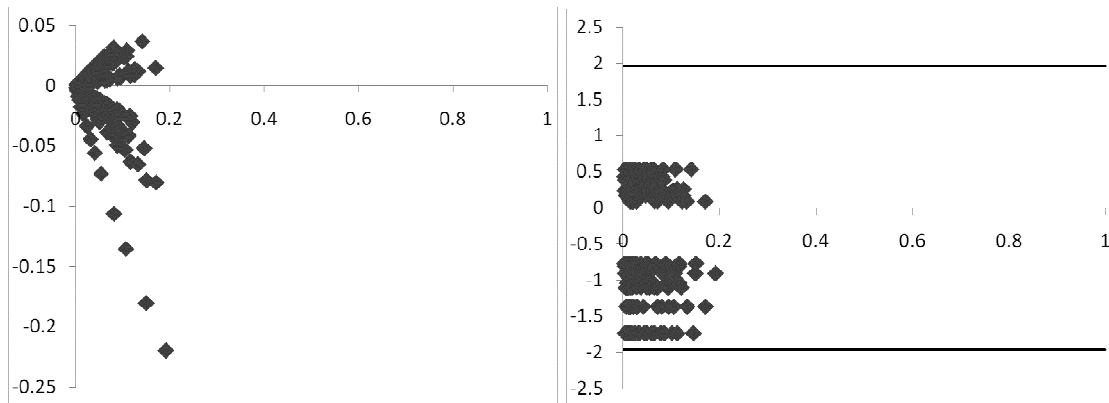


Figure A9.4: (i) Marginal effects of routinisation; (ii) t-statistics of marginal effects

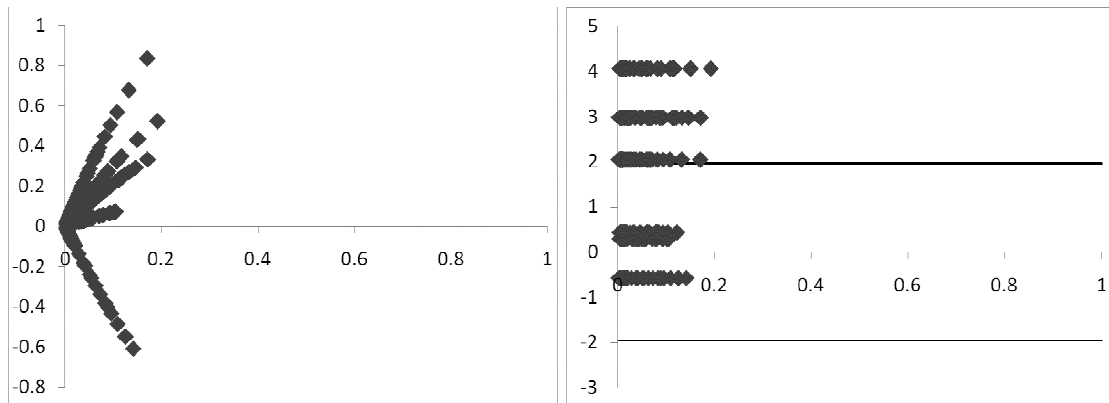


Figure A9.5: (i) Interaction effects of academic qualification level 2-3 and routinisation; (ii) t-statistics of interaction effects

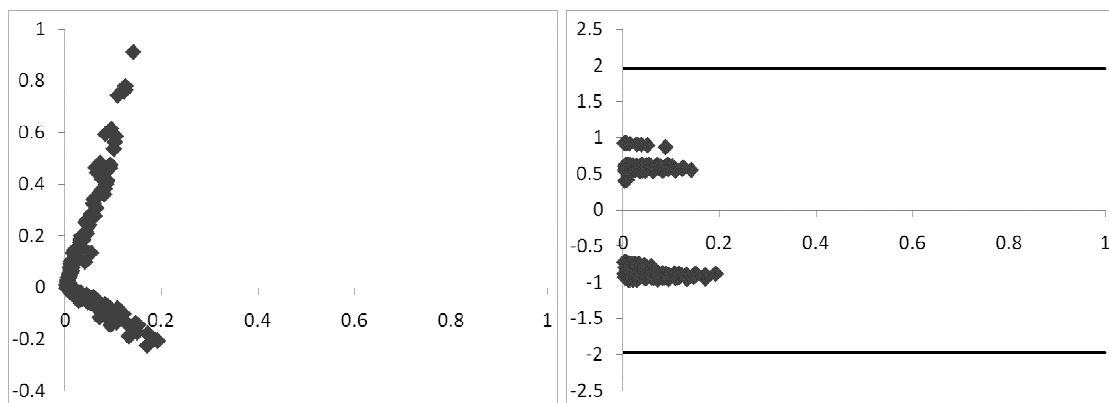


Figure A9.6: (i) Interaction effects of academic qualification level 4-5 and routinisation; (ii) t-statistics of interaction effects

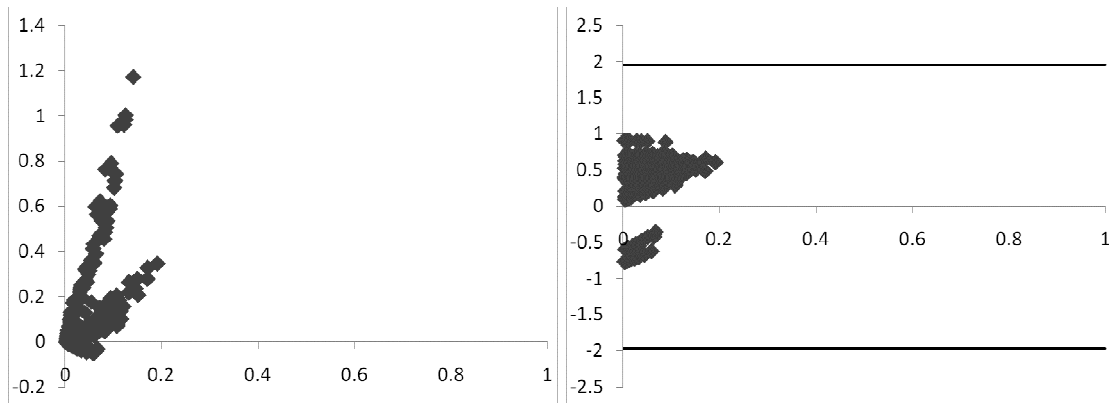


Figure A9.7: (i) Interaction effects of vocational qualification level 4-5 and routinisation; (ii) t-statistics of interaction effects

