

A DOUBLE COHORT ANALYSIS OF RESIDENTIAL OVERCROWDING AMONG IMMIGRANTS IN NORWAY

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ABSTRACT:

Residential overcrowding in Norway, measured as more than one person per room, was found to decline rapidly for Norwegians and immigrant cohorts between 1980 and 1990. The results show that the decline in overcrowding propensities for immigrant cohorts over time is not only determined by years of residence in Norway, but also changes in age, disposable income and tenure status. It was shown that “cohort analysis” constrains the impact of aging to be equal for members of immigration cohorts, thus providing insufficient measure of the actual impact of the aging process on overcrowding among different immigrant generations (birth cohorts) in Norway.

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I. INTRODUCTION

The basic question addressed in this paper is whether immigrants to Norway are more likely to live in overcrowded housing than are Norwegians. If so, whether the likelihood to live in overcrowded housing diminishes as immigrants adjust to the living arrangements of Norwegians over time. There are good reasons to believe that immigrant households would be more overcrowded than there would be for Norwegians. First, the ethnic composition of immigrants to Norway has changed dramatically over the last two decades. Prior to 1970, immigrants to Norway originated mainly from the other Nordic countries – Finland, Denmark and Sweden (Hayfron 1998b). However, beginning in 1970, the source country composition shifted, leading to increased flows of immigrants from less-developed countries (SOPEMI 1996, 1998). Since these immigrants have different cultural background, their living arrangement preferences are likely to differ from that of Norwegians.

Second, immigrants and Norwegians may differ in terms of family size and composition, because of differences in fertility rates.² The larger the family size, the higher the likelihood that individuals would experience overcrowding. Moreover, housing policies such as room norms, which specify how many people can share a flat, may differ for Norway and the countries from which immigrants originate. For this reason, immigrants, particularly those from the developing countries, may have a different perception regarding household densities, and therefore demand for more traditional (i.e. extended) household arrangements upon arrival in Norway.

Finally, previous studies in Norway have shown that immigrants, depending on duration of residence in Norway, receive lower average earnings compared to Norwegians (e.g., Hayfron 1998a). Given the close link between affordability and realization of individual preferences, the living arrangement status of immigrants should initially be different from that of Norwegians. However, the living arrangement statuses of immigrants and Norwegians should converge as the earnings gap narrows over time. While empirical evidence exists that immigrants' earnings

² The average fertility rates in Norway were 1.70 for Norwegians, 1.67 for other Scandinavian immigrants, 1.86 for other European immigrants, 1.92 for immigrants from the other industrialized countries and 3.08 for Third World immigrants respectively. However, the total fertility rate among immigrants declines with years of residence in Norway (SOPEMI 1990).

converge towards that of Norwegians (Hayfron 1998a), there is no empirical evidence to suggest that immigrants' rate of overcrowding also converges towards that of Norwegians over time. This paper provides new evidence on immigrants overcrowding assimilation in Norway.

To be able to compare the findings of this study with previous studies in Norway and elsewhere, I review the literature on immigrants' residential overcrowding in the next section. In Section III, I describe the data, and provide a descriptive analysis of some key variables. In Section IV, I present the results from the logistic regression models, while Section V analyzes the impact of assimilation on immigrants' overcrowding propensities. Section VI extends the analysis in V. Here, I apply the double cohort technique on Norwegian data. Section VII concludes the analysis.

II. EARLIER STUDIES

Recent studies in Norway have shown that immigrants, particularly those from non-Western countries, on average live in more crowded conditions than Norwegians (Hansen 1994, Weekly Bulletin no 7, 1997). Low average disposable income, lack of access to capital, different preferences, or different values placed on housing consumption relative to other forms of consumption were cited as some of the explanations for immigrants' poor living conditions in Norway. However, residential overcrowding is not static, and it is expected to change over time. Therefore, using a single snapshot approach to provide qualitative analysis of overcrowding may not have serious policy implications.

In the U.S., Myers and Lee (1996) found differences in residential overcrowding among race/ethnic groups in Southern California. They found that cohorts' growth in income contributes substantially to the decline in overcrowding among Hispanics, Asians and non-Hispanic whites over time. Burr and Mutchler (1993) test two alternative hypotheses about how economic status conditions the impact of culture on living arrangements among Hispanic groups in the US. They found that as economic status increases, the impact of cultural factors on living arrangement status diminishes for Mexican American and Puerto Rican women, but not for Cuban women.

Focusing on immigrants aged 55 years and over in Canada, Basavarajappa (1998) found that 2 percent of Canadian-born persons in this age range live in overcrowded households as compared to 6 percent of immigrants. He also found overcrowding to be higher (28 percent to 52 percent) among immigrants from the developing countries than it is among those from the developed countries (0-15 percent). Years of residence in Canada were found to have a greater impact on the overcrowding experience of immigrants from developing countries, than that of immigrants from developed countries.

III. THE DATA

The database used for this analysis is the Norwegian Population and Housing Census Databank (FTDB). The Census Databank offers a 10 percent sample from the 1960, 1970, 1980 and 1990 population and housing censuses linked on an individual level. For the purposes of this study, the complete 9,080 observations on immigrants aged 17–66 in the census databank were used. A person is classified as an immigrant if that person was born outside Norway, has non-Norwegian parentage and is domiciled in Norway (St meld no 17). In addition, a randomly drawn sample of 9,080 Norwegians was used to match the immigrant sample. Observations with missing information were dropped from the analysis. FTDB provides detailed information on the number of rooms and number of persons (adults and children) in the household. Both males and females can be homeowners. However, the data do not distinguish between male and female household heads. Therefore, each is counted as a household head when either or both own or rent a dwelling unit. Based on this information, crowding was defined as the number of persons per room, while “overcrowding” is measured as more than one person per room. This definition

is consistent with the definition in the Norwegian official statistics.³

Age Cohorts. Age is defined as the census year (1980, 1990) minus the year of birth. For the purpose of this study, five age categories were used. They are 17–26, 27–36, 37–46, 47–56 for 1980, and 27–36, 37–46, 47–56, 57–66 for 1990. The reference age cohorts are 17–26 (27–36) for 1980 (1990) respectively.

Educational Level. Four categories were used for education. They are less than 12 years of schooling plus those with unknown educational level, 12 years of schooling (High School graduates), and 14 years or more schooling (College and University graduates). The reference category is those with less than 12 years of schooling or unknown educational level.

Gender. The gender dummy variable is set to 1 if male and 0 if female.

Marital Status. The marital status variable has two categories, married and not married. The later category includes separated or divorced, widow (widower) or never married.

Tenure Status. The tenure status variable has two categories, homeowner and renter. The homeowner category includes single owner or collective ownership, while the renter category includes renting, housing in connection with the job “cotter’s contract”, or renting agreement with time limit.

Residential location. Three dummies were used to represent three broad geographical areas. The southern region, western region and northern region. The reference category is southern region.

Arrival Cohort. The census data do not have information on individuals year of arrival in Norway. However, the “personal identification” variable in the data provides information on the individual participation in the various population censuses in the country. By law these people might have been residents of Norway at least six months prior to the census count. Using this information, seven dummy variables were constructed. They are arrivals before 1960, arrivals

³ There is no consensus regarding the definition of overcrowding. However, the definition used in this study seems to be the standard definition used by most researchers. Myers and Lee (1996) use more than 1.5 persons per room as the indicator of overcrowding.

in 1960–69, arrivals in 1970–79 and arrivals in 1980–89. The prior to 1960 was the omitted arrival cohort.

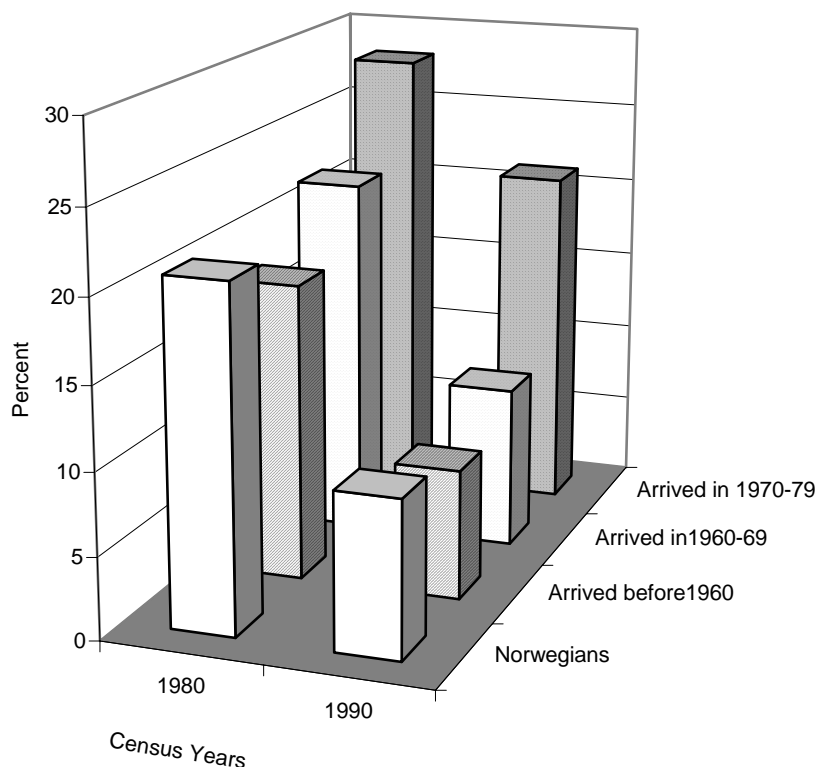


Figure 1. Trends in Residential Overcrowding in Norway: 1980–1990

Figure 1 shows the proportion of immigrant cohorts, and Norwegians that lived in overcrowded housing between 1980 and 1990. Three findings are evident in Figure 1. First, a higher proportion of immigrants and Norwegians lived in overcrowded housing in 1980. Second, both immigrants and Norwegians experienced a decline in overcrowding between 1980 and 1990. Finally, the rate of overcrowding among immigrants converges rapidly towards (and overtake) that of Norwegians over time. For example, the 1990 data shows that the initial overcrowding gap between immigrants and Norwegians dropped from 14.5 percentage points for immigrants with 1-10 years of residence, to 11.6 percentage points for those with 10-20 years of residence, to 0.4 percentage points for those with 20-30 years of residence and finally, to –1.6 percentage points for those with 30 years or more residence in Norway.

Table 1. Age Distribution of Arrival Cohorts

Age Cohorts	Arrival Cohorts							
	1980				1990			
	Pre1960	1960-69	1970-79	Pre1960	1960-69	1970-79	1980-89	
17-26	22.8	20.5	28.5	<i>N.A.</i>	<i>N.A.</i>	<i>N.A.</i>	<i>N.A.</i>	
27-36	14.8	27.5	50.6	22.1	19.6	29.0	66.3	
37-46	26.7	42.1	17.9	15.8	29.2	49.0	26.0	
47-56	35.8	9.8	2.9	26.4	41.1	17.7	6.4	
55-66	<i>N.A.</i>	<i>N.A.</i>	<i>N.A.</i>	35.7	10.1	4.3	1.3	

N.A.: Not applicable

Several factors may explain the downward trend in residential overcrowding between 1980 and 1990. One important factor is age. For example, overcrowding tends to be lower (or declines more) for the pre-1960 and 1960-69 cohorts, which have a higher proportion of persons in their late forties or older, than the 1970-79 and 1980-89 arrival cohorts with younger persons. As Table 1 shows, 66.3 percent of immigrants who arrived in 1980-89 are in their prime ages, 27-36, as of 1990. On the whole, immigrants tend to be younger on average than Norwegians. This may partly explain why immigrants experienced fewer declines in overcrowding than Norwegians (see Figure 2).

Figure 2. The Decline in Overcrowding Propensity for Persons aged 17-56 in 1980

Table 2 shows that as overcrowding declined, there were substantial improvements in the economic status of immigrants and Norwegians. Average disposable income for the 1960-69 immigrant cohort, for example, increased from NOK 81,727 to NOK115, 963 between 1980 and 1990.⁴ Homeownership rates among Norwegians and immigrant cohorts also increased substantially over the decade. Thus, the decline in overcrowding might have been caused by the increase in the disposable income and the rapid movement into homeownership over the decade. Specifically, for those who view overcrowding as a problem, the income growth was probably sufficient to raise them to the point, which they could afford to purchase a spacious housing.

Table 2

Mean Disposable Incomes (in 1989 Norwegian Kroner) and Tenure Status of Immigrant Cohorts and Norwegians between 1980 and 1990.

	1980	1990	1990-1980
<i>1980-89 Cohort</i>			

⁴ The 1980 income was adjusted to the level of 1990 income using the consumer price index, 2.312.

Mean Income (NOK)	N.A.	110,554	N.A.
Homeowner (%)	N.A.	60.7	N.A.
Renter (%)	N.A.	39.3	N.A.
<i>1970-79 Cohort</i>			
Mean Incomes (NOK)	85,270	128,265	42,995
Homeowner (%)	46.5	81.5	35
Renter (%)	53.5	18.5	
<i>1960-69 Cohort</i>			
Mean Income (NOK)	81,727	115,963	34,236
Homeowner (%)	76.1	86.8	10.7
Renter (%)	23.9	13.2	
<i>Pre1960 Cohort</i>			
Mean Income (NOK)	88,312	114,434	26,122
Homeowner (%)	77.2	85.0	7.8
Renter (%)	22.8	15.0	
<i>Norwegians</i>			
Mean Income (NOK)	85,315	124,507	39192
Homeowner (%)	79.1	86.6	7.5
Renter (%)	20.9	13.4	

IV. LOGIT ESTIMATION OF RESIDENTIAL OVERCROWDING

The logit models, in equations (1) to (4) in Appendix B, were estimated separately for Norwegians and immigrants aged 17–56 in 1980 and 27–66 in 1990, using samples for 1980 and

1990 respectively.⁵ The description of the explanatory variables is reported in Appendix A. Disposable income was not included in the logistic regression models because of a high correlation between income and the rest of the explanatory variables.⁶

The maximum likelihood estimates, asymptotic *t*-statistics (against the null hypothesis that the coefficient is zero), mean values of the explanatory variables and their marginal effects on overcrowding propensities are presented in Table 3. Direction of influence and statistical significance of most of the explanatory variables are consistent with the literature (see, e.g. Burr and Mutchler 1993; Myers and Lee 1996; Basavarajjapa 1998). The negative coefficients of the age dummy variables indicate that older Norwegians and immigrants are less likely to live in overcrowded housing than their younger counterparts.⁷ The results show that Norwegians and immigrants, who have acquired a high school, or a college or a university degree, are less likely to experience overcrowding than those with less than high school degree. Norwegian males are more likely to experience overcrowding than their female counterparts. This is also true for immigrant men in the 1980 sample. The positive effect of marital status on the overcrowding propensities for both Norwegians and immigrants may reflect the effects of children.⁸ Married couples are more likely to have children and therefore experience overcrowding, as compared to those who are not married.

⁵ A likelihood ratio test indicated that there were structural changes in the overcrowding probabilities for Norwegians and immigrants between 1980 and 1990. The calculated values of $\chi^2 = 90.43$ for Norwegians and $\chi^2 = 90.98$ for immigrants exceed respectively, the tabulated values at both the 95 and 99 percent confidence levels with 22 and 28 degrees of freedom. A detailed description of how the test of equivalence of submodels was conducted is available upon request.

⁶ In a preliminary analysis, I estimated the overcrowding equations by including disposable income as an explanatory variable. I found the coefficients of disposable income to be negative and significantly different from zero for only Norwegians in the 1990 sample.

⁷ Myers and Lee (1996) pointed out that the chances of experiencing overcrowding first decline as children grow into teenage years, then rise as they enter prime childbearing years, and finally fall as parents' children reach teenage years and eventually leave home. Following this argument, five age dummies were included in the study.

⁸ Number of children was not included as an explanatory variable in the logit regressions, because of the definition of crowding. Crowding was measured as the number of persons in the household divided by the number of rooms in the household. Children were counted as part of persons in the household.

The results show that unlike Norwegians, immigrants are more likely to live in overcrowded housing in the southern region than in any other region in the country.⁹ As discussed earlier, more immigrants owned houses in 1990 than they did in 1980. Thus, it could be argued that overcrowding decreased as a result of movement into homeownership among immigrants.¹⁰ To test this hypothesis, a tenure status dummy (1 = own, 0 = rent) was used as an explanatory variable in the logistic regression models. The results show that immigrants who moved into homeownership are likely to reduce overcrowding by 11.8 and 7.9 percentage points in 1980 and 1990. The comparable figures for Norwegians are 7.8 and 5.3 percentage points respectively.

Of primary importance to this study are the coefficients of the year of arrival dummies. All but the coefficients for the 1960–69 cohort are positive and significantly different from zero, indicating that most recent immigrants are more likely to live in overcrowded housing than the pre-1960 cohort (reference cohort). This is consistent with the assimilation hypothesis, which suggests that the longer the duration of residence in Norway, the more likely it is that immigrants will have similar living arrangement status as Norwegians.

V. ASSIMILATION AND RESIDENTIAL OVERCROWDING

In order to describe fully the impact of assimilation on immigrants' overcrowding probabilities, I implemented the cohort analysis technique suggested by Borjas (1985, 1986). First, I calculated the probabilities (\hat{P}) of overcrowding using equations (7) to (11) in Appendix B. Next, the cross-sectional change in overcrowding probabilities in period t , was measured as the difference between the overcrowding propensities for immigrants who arrived in Norway in year k and those who arrived ten years later, $k+10$ i.e. ($\hat{P}_{T,K} - \hat{P}_{T,K+10}$). The cross-section measure of assimilation is summarized in column 1, panel A of Table 4.

⁹ A frequency distribution (not reported) shows that 77.3 percent (73.3 percent) of immigrants lived in overcrowded housing in the southern region in 1980 (1990). The comparable figures for Norwegians are 49.2 percent and 44.8 percent respectively.

¹⁰ Cheven (1971) found for the U.S. that immigrant household tends to move into larger housing, as family size increases over time.

The cross-section change in overcrowding propensities indicates that immigrants who arrived in 1960–69 are -0.0156 percentage points less likely to experience overcrowding than the 1970–79 cohort. Cross-sectional analysts (e.g., Chiswick 1978) would interpret the 1.6 percentage points difference as implying the differences in the duration of residence in Norway between two arrival cohorts. This interpretation is invalid if, for example, members of the 1970–79 cohort have different preferences for living arrangements on the average (perhaps due to changes in the ethnic composition), than members of the 1960–69 cohort.¹¹

To investigate this possibility and provide a more reliable measure of assimilation, I decomposed the cross-section change in overcrowding probabilities using equation (12) in Appendix B, into within-cohort and across-cohort effects respectively. The within-cohort change in row 1, column 2 indicates that as of 1990, the 1960–69 immigrant cohort had overcrowding probability that was 8.9 percentage points lower than in 1980. Moreover, the across-cohort change in column 3, indicates that the overcrowding propensity for the 1960–69 immigrant cohort in 1980 was 7.4 percentage points higher than that of the 1970–79 immigrant cohort in 1990.¹² Hence, it is reasonable to assume that assimilation have had little, if any, direct impact on changes in immigrants' overcrowding propensities. The second row replicates the cohort analysis for the 1970–79 immigrant cohort.

The years covered in this analysis, 1980 to 1990, were characterized by an increasing flow of immigrants, particularly from the developing countries to Norway, and the 1982 world-wide recession. These period events may affect the skill composition and the performances of both Norwegians and immigrants in both the labour market and housing market respectively.¹³ To simplify the analysis, I assume that these period events affected the overcrowding propensities for immigrants and Norwegians equally. Given this assumption, I net out these effects by comparing the changes in overcrowding propensities experienced by immigrants with

¹¹ Other explanations are possible. Living arrangement preferences would be different, if members of the 1970-79 cohort have fewer skills to succeed in the Norwegian labor market than their 1960-69 counterparts. Similarly, if those who arrived in 1970-79 include contract workers with short-term work permits in Norway, they may prefer co-residence/renting to purchasing a house. Thus, becoming more prone to overcrowding than the 1960-69 cohort.

¹² It must be noted, however, that both the 1960-69 arrival cohort in the 1980 sample, and the 1970-79 arrival cohort in the 1990 sample have the same number of years of residence in Norway, i.e., 10-20 years.

¹³ For instance, the 1982 recession led to a relatively high rate of unemployment among immigrants in Norway.

the changes in overcrowding propensities experienced by Norwegians between 1980 and 1990 (see Borjas 1986). The within-cohort change in column 4 of Table 4, indicates that the change (a decline) in overcrowding propensities experienced by the 1960–69 immigrant cohort was 2.8 percentage points more than the change experienced by Norwegians, between 1980 and 1990. Similarly, the across-cohort change in the last column indicates that recent immigrants are more likely to experience overcrowding than are earlier immigrants. The second row replicates the cohort analysis for the 1970–79 immigrant cohort.

VI. THE DOUBLE COHORT ANALYSIS

Myers and Lee (1996) have criticized Borjas' (1985) cohort analysis approach, arguing that it constrains the impact of aging to be equal for members of immigration cohorts. They pointed out that "Because population members are identified dually by membership in both birth cohort and an immigration cohort, over time their age and duration change in tandem (1996: 54)." Hence, the changes in overcrowding between 1980 and 1990 may be due to both aging and duration effects. To be able to separate aging effects from duration effects, these authors propose the "double cohort design." This method nests birth cohorts within immigration cohorts. I implement the double cohort method in this analysis of immigrants' overcrowding experience in Norway.

I begin the analysis with a graphical representation of various scenarios that emerge from applying both the double cohort design (Figures 3–5, and 7–9), and the cohort analysis method (Figures 6 and 10) on Norwegian data. The probability distributions in Table 5 were used to plot these graphs. These figures measure changes in overcrowding propensities between 1980 and 1990, during which the ages of Norwegians increased by ten years, while the duration of residence in Norway and ages of immigrants increased by ten years respectively.

A visual inspection of these figures would reveal some discrepancies between the "double cohort" design and the "cohort analysis" method, especially with regard to the rate at which the overcrowding propensities change as individuals grow older. For example, the double cohort design predicts a rapid convergence between the overcrowding profiles of the 1960–69 cohort and Norwegians, as individuals move from age 27–36 to 37–46 to 47–56 and to 57–66

over the decade. On the contrary, the cohort analysis method predicts an initial convergence and then a divergence of overcrowding profiles in the later part of the life cycle (see Figure 6). This ambiguity becomes more pronounced if one compares the overcrowding profiles of the 1970–79 immigrant cohort with that of Norwegians (see Figure 10).

In light of these differences, I decomposed the differences in overcrowding propensities between immigrants who belong to the same age group, but belong to different arrival cohorts using the following formula:

$$\hat{P}_{T,K,A} - \hat{P}_{T,K+10,A} = (\hat{P}_{T,K,A} - \hat{P}_{T-10,K,A-10}) + (\hat{P}_{T-10,K,A-10} - \hat{P}_{T,K+10,A}).$$

Where $\hat{P}_{T,K,A} = \left\{1 + \exp\left[-(\bar{X}\hat{\beta}_T + \hat{\alpha}_K + \hat{\delta}_A)\right]\right\}^{-1}$ is the overcrowded probability, $\hat{\beta}$, $\hat{\alpha}$ and $\hat{\delta}$ are the estimated coefficients taken from Table 3, and \bar{X} is a vector of individual characteristics (excluding age). Note that $\hat{\alpha}_k = 0$ for Norwegians. The subscripts $T =$ Census year, $K =$ Year of arrival and $A =$ Age cohort.

The results from the second decomposition are summarized in panel B of Table 4. The within-cohort and across-cohort changes in overcrowding propensities display a similar pattern to those in panel A, and should be interpreted in a similar manner. The only difference is that the magnitude of the change in overcrowding propensities for the various immigrant cohorts differs by age, which is consistent with the graphical representations. The reader can compare the estimates in panels A and B to see the difference. These discrepancies imply that treating members of a particular arrival cohort as if all of them belong to the same age group will not adequately measure the actual impact of aging on immigrants' overcrowding propensities.

Again to net out the effects of period events, Norwegians belonging to various age groups were used as references in this double cohort analysis. The within-cohort change indicates that the changes in overcrowding propensities vary by age cohorts. For example, members of the 1960–69 arrival cohort, who moved from age 27–36 in 1980 to age 37–46 in 1990, experienced a change in overcrowding propensity that was 1.5 percentage points more than the change experienced by Norwegians who were in the same age group (27–36) in 1980. This is lower than the 2.8 percentage points predicted by Borjas' method (see panel A). Comparable figures for immigrants aged 37–46 to 47–56 and aged 47–56 to 57–66 are 3.3 and

1.7 percentage points respectively. A similar conclusion can be drawn for immigrants who belong to both the 1970–79 arrival cohort and various age cohorts. Finally, the across-cohort change also shows some inconsistencies between the results obtained from using the Myers/Lee approach and that of Borjas.

VII. SUMMARY AND CONCLUSIONS

A policy-related question addressed in this study is whether immigrants to Norway are more likely to live in overcrowded housing (i.e., more than one person per room) than Norwegians. If so, whether the propensity to live in overcrowded housing diminishes as immigrants adjust to the living arrangements of Norwegians over time. To answer this question, I estimated separate logistic regression models for immigrants and Norwegians using samples drawn from the 1980 and 1990 population and housing censuses respectively. Age, education, tenure status and year of arrival were found to play important roles in explaining the overcrowding propensities for immigrants and Norwegians in Norway. The results show that the 1980–89 cohort is more likely to live in overcrowded housing than both the earlier immigrant cohorts and Norwegians. This may be due to assimilation. However, the assimilation effect was found to be much smaller than those inferred from the cross-sectional measure.

The other important factor is that both immigrants and Norwegians experienced a decline in overcrowding between 1980 and 1990. The decline in overcrowding was more among the 1960–69 cohort, and less among Norwegians and the 1970–79 cohort. There are several reasons for this decline. First, the decline in overcrowding may reflect the aging of the Norwegian population. Second, consistent with the findings of Myers and Lee (1996), increased disposable incomes partly explain the decline in overcrowding for both Norwegians and immigrants. The analysis also shows that more immigrants owned houses in 1990 than they did in 1980.

Finally, comparing the Borjas (1985) “cohort analysis” with the “double cohort design,” attributable to Myers and Lee (1996), I found that although the cohort analysis provides a fine measure of assimilation on overcrowding propensities of immigrants, it has some limitations. For example, it constrains the impact of aging to be equal for members of immigration cohorts; thus,

providing an insufficient measure of the actual impact of the aging process on residential overcrowding among different immigrant generations (birth cohorts) in Norway.

Although, this study has some weaknesses (either due to unavailability of key variables such as Norwegian language proficiency, or inadequate data to merit separate analysis for various ethnic groups), the findings may have some policy relevance. They will enable Norwegian policymakers to evaluate the outcomes of the government's integration and housing policies over the decade 1980–1990. It is important to note that a decline in overcrowding implies an improvement in the living conditions of both Norwegians and immigrants. Residential overcrowding may have an adverse effect on the health of residents. Given that health is a form of human capital, overcrowding would affect individual productivity; therefore, the decline in overcrowding should be a success story for Norway.

APPENDIX A:

APPENDIX B. Model Specification

The relationship between overcrowding and individual characteristics, can be expressed as

$$(1) \quad y_i^* = X_i \beta_i + u_i$$

where X is a vector of individual characteristics, β_i is a vector of unknown parameters to be estimated, and u_i is the random disturbance term assumed to have a logistic distribution. In practice, y_i^* is not observed (Maddala 1983). What we observe is a dummy variable y defined as

$$(2) \quad y_i = 1, \text{ if } y_i^* > 0$$

$$y_i = 0, \text{ otherwise}$$

Combining (1) and (2), and using an algebraic manipulation it can be shown that $E(y_i) = X_i \beta_i = p_i$. Transforming p_i (the chances of events occurring) to odds ratio and taking logarithm of the odds, the logistic regression models can be obtained by setting the log-odds equal to a linear function of the explanatory variables. For the purposes of this study, these logistic regression models were estimated by maximum likelihood.

$$(3) \quad \ln\left(\frac{P_{80}}{1 - P_{80}}\right) = X\beta_{80} + \alpha_{70-79}C + \alpha_{60-69}C + \nu_{80},$$

$$(4) \quad \ln\left(\frac{P_{90}}{1 - P_{90}}\right) = X\beta_{90} + \alpha_{80-89}C + \alpha_{70-79}C + \alpha_{60-69}C + \nu_{90},$$

$$(5) \quad \ln\left(\frac{P_{80}}{1 - P_{80}}\right) = X\lambda_{80} + \nu_{80},$$

$$(6) \quad \ln\left(\frac{P_{90}}{1 - P_{90}}\right) = X\lambda_{90} + \nu_{90},$$

where P_t is the overcrowding probability in Census year t ($=1980,1990$), X is a vector of individual characteristics, while the dummies C represent the arrival cohorts as defined in section A above.

Define the overcrowding probability as,

$$(7) \quad \hat{P}_{80,1960-69} = \left\{ 1 + \exp\left[-(\bar{X}\hat{\beta}_{80} + \hat{\alpha}_{1960-69})\right] \right\}^{-1},$$

$$(8) \quad \hat{P}_{90,1960-69} = \left\{ 1 + \exp\left[-(\bar{X}\hat{\beta}_{90} + \hat{\alpha}_{1960-69})\right] \right\}^{-1},$$

$$(9) \quad \hat{P}_{90,1970-79} = \left\{ 1 + \exp\left[-(\bar{X}\hat{\beta}_{90} + \hat{\alpha}_{1970-79})\right] \right\}^{-1},$$

$$(10) \quad \hat{P}_{80,N} = \left\{ 1 + \exp\left[-(\bar{X}\hat{\lambda}_{80})\right] \right\}^{-1},$$

$$(11) \quad \hat{P}_{90,N} = \left\{ 1 + \exp\left[-(\bar{X}\hat{\lambda}_{90})\right] \right\}^{-1}.$$

Note that equation (9) shows the overcrowding probability of individuals who arrived in Norway ten years later. These have the same number of years of residence as those who arrived in 1960–69 as of 1980. cross-section change in assimilation, $\hat{P}_{90,1960-69} - \hat{P}_{90,1970-79}$ can be decomposed as

$$(12) \quad \hat{P}_{90,1960-69} - \hat{P}_{90,1970-79} = (\hat{P}_{90,1960-69} - \hat{P}_{80,1960-69}) + (\hat{P}_{80,1960-69} - \hat{P}_{90,1970-79}).$$

Where the first component measures the within-cohort effect, while the second component measures the across-cohort effect respectively. The within-cohort effect measures the actual impact of assimilation on overcrowding propensity. Using Norwegians as the base group, a similar decomposition can be done using,

$$(13) \quad \hat{P}_{90,1960-69} - \hat{P}_{90,1970-79} = \left[\left(\hat{P}_{90,1960-69} - \hat{P}_{80,1960-69} \right) - \left(\hat{P}_{90,N} - \hat{P}_{80,N} \right) \right] + \left[\left(\hat{P}_{80,1960-69} - \hat{P}_{90,1970-79} \right) - \left(\hat{P}_{80,N} - \hat{P}_{90,N} \right) \right].$$

Where the first component on the right hand side of (13) measures the within-cohort effect, and the second component measures the across-cohort effect.

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Table 3
Maximum Likelihood Logit Regressions on Probability of Living in Overcrowded Housing

	1980 Census						1990 Census					
	Norwegians			Immigrants			Norwegians			Immigrants		
	<i>Coeff</i>	<i>Mean</i> (<i>S.D.</i>)	<i>M.E.</i>	<i>Coeff</i>	<i>Mean</i> (<i>S.D.</i>)	<i>M.E.</i>	<i>Coeff</i>	<i>Mean</i> (<i>S.D.</i>)	<i>M.E.</i>	<i>Coeff</i>	<i>Mean</i> (<i>S.D.</i>)	<i>M.E.</i>
Constant	-1.0942 (-10.305)			-1.1949 (-5.770)			-1.6190 (-11.822)			-2.4834 (-10.427)		
<i>Age cohorts</i> ¹												
27 – 36	-.4136 (-4.115)	.3191 (0.466)	-.0650	-.1584 (-1.020)	.3663 (0.482)	-.0274	<i>N.A.</i>			<i>N.A.</i>		
37 – 46	-.4607 (-4.144)	.2176 (0.413)	-.0724	-.3052 (-1.734)	.2709 (0.445)	-.0528	-.5686 (-5.446)	.3095 (0.462)	-.0411	-.1556 (-1.936)	.3112 (0.463)	-.0221
47 – 56	-1.0259 (-7.882)	.1637 (0.370)	-.1613	-.4613 (-1.982)	.1133 (0.317)	-.0798	-1.1689 (-8.598)	.2203 (0.415)	-.0845	-.4311 (-3.548)	.1406 (0.348)	-.0612
57 – 66	<i>N.A.</i>			<i>N.A.</i>			-1.8150 (-9.288)	.1540 (0.361)	-.1313	-1.3340 (-4.811)	.0516 (0.221)	-.1894
<i>Education</i> ²												
High School	-.5546 (-6.499)	.2738 (0.446)	-.0872	-.7451 (-6.143)	.3897 (0.488)	-.1290	-.4359 (-4.347)	.3294 (0.470)	-.0315	-.2819 (-3.472)	.2861 (0.452)	-.0400
College & University	-.9890 (-5.280)	.0593 (0.236)	-.1555	-1.1293 (-5.729)	.1302 (0.337)	-.1955	-.9003 (-5.109)	.1066 (0.309)	-.0651	-.7212 (-7.210)	.1888 (0.391)	-.1024
Gender (1=Male, 0=Female)	.2425 (3.383)	.5219 (0.500)	.0381	.2800 (2.517)	.4940 (0.500)	.0485	.1630 (1.807)	.5081 (0.500)	.0118	-.0939 (-1.337)	.5402 (0.498)	-.0133
Marital Status (1=Married)	.7088 (7.701)	.6405 (0.480)	.1115	.8484 (5.831)	.6978 (0.459)	.1468	.6999 (6.422)	.6900 (0.463)	.0506	1.6648 (16.633)	0.6842 (0.465)	.2364
Tenure Status (1=Own, 0=Rent)	-.4949 (-6.018)	.7906 (0.407)	-.0778	-.6805 (-5.831)	.6153 (0.487)	-.1178	-.7332 (-6.221)	.8665 (0.340)	-.0530	-.5543 (-7.172)	.6996 (0.459)	-.0787
<i>Residential Location</i> ³												
West	.1681 (2.227)	.3611 (0.480)	.0264	-.2886 (-2.067)	.2112 (0.408)	-.0500	.3449 (3.635)	.3631 (0.481)	.0249	-.3328 (-4.029)	.2594 (0.438)	-.0473
North	.4060 (3.539)	.0980 (0.297)	.0638	-.0818 (-.328)	.0517 (0.222)	-.0142	.5760 (4.082)	.0918 (0.289)	.0417	-.3129 (-1.809)	.0477 (0.213)	-.0444

Arrival Cohorts⁴

1960 – 69	N.A	.2575 (1.467)	.3096 (0.463)	.0446	N.A	.0455 (.184)	.1055 (0.307)	.0065
1970 – 79	N.A	.4993 (2.838)	.4985 (0.500)	.0864	N.A	.7403 (3.401)	.2361 (0.425)	.1051
1980 – 89	N.A	N.A	N.A		N.A	.8819 (4.118)	.5931 (0.491)	.1252
$\ln L_{\max}$	-2522.4	-1035.6			-1822.6	-2583.0		
$\ln L_0$	2627.3	-1115.8			-1953.3	-2885.5		
$\chi^2_{12} = -2(\ln L_0 - \ln L_{\max})$	209.79	160.3			261.3	604.13		
Sample Size	5143	2012			6200	5620		
Predicted probabilities (\hat{P})	0.1954	0.2227			0.0785	0.1713		

Notes:

¹. Reference age cohort: Age 17 – 26 for the 1980 sample and age 27 – 36 for the 1990 sample.

². Reference education: Less than high school plus unknown educational level

³. Reference geographical region: Southern Norway

⁴. Reference arrival cohort: Pre1960 arrivals

M.E.: Marginal Effects calculated as $\frac{\partial \hat{P}_i}{\partial X_k} = \hat{\beta}_k \hat{P}_i (1 - \hat{P}_i)$.

N.A.: Not applicable.

T-statistics (against the null hypothesis that the coefficient is zero) in parentheses

Table 4
Decomposition of Changes in the Probability of Residential Overcrowding

Arrival and Age Cohorts	Cross-Section (1)	Immigrants Only		Relative to Norwegians	
		Within-Cohort (2)	Across-Cohort (3)	Within-Cohort (4)	Across-Cohort (5)
<i>Panel A: Assimilation Effects</i>					
1960 – 1969	–0.0154	–0.0893	0.0739	0.0277	–0.0431
1970 – 1979	–0.0386	–0.1005	0.0619	0.0165	–0.0551
<i>Panel B: Assimilation and Aging Effects</i>					
<i>1960 – 1969 Cohort</i>					
27–36 to 37–46	–0.0171	–0.0987	0.0817	0.0151	–0.0322
37–46 to 47–56	–0.0169	–0.0959	0.0790	0.0326	–0.0495
47–56 to 57–66	–0.0168	–0.1016	0.0848	0.0168	–0.0336
<i>1970 – 1979 Cohort</i>					
27–36 to 37–46	–0.0424	–0.1105	0.0680	0.0034	–0.0458
37–46 to 47–56	–0.0421	–0.1074	0.0654	0.0211	–0.0631
47–56 to 57–66	–0.0418	–0.1137	0.0719	0.0047	–0.0465

Notes:

Predicted probabilities (\hat{P}_k) for arrival cohorts 1960s and 1970s in the 1980 sample are: 0.1814 and 0.2140, while the probabilities for arrival cohorts 1960s, 1970s and 1980s in 1990 sample are: 0.0946, 0.1137 and 0.1603 respectively.

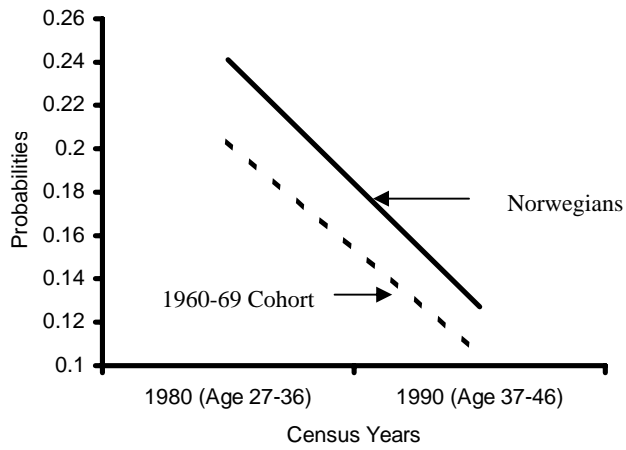


Figure 3. Overcrowding Propensities for Persons aged 27-36 in 1980

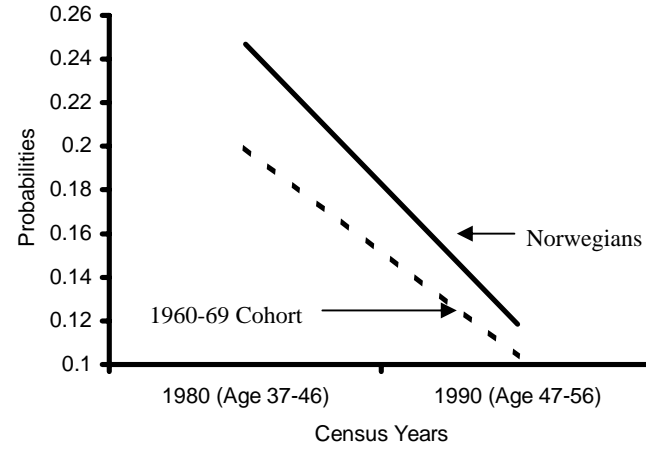


Figure 4. Overcrowding Propensities for Persons aged 37-46 in 1980

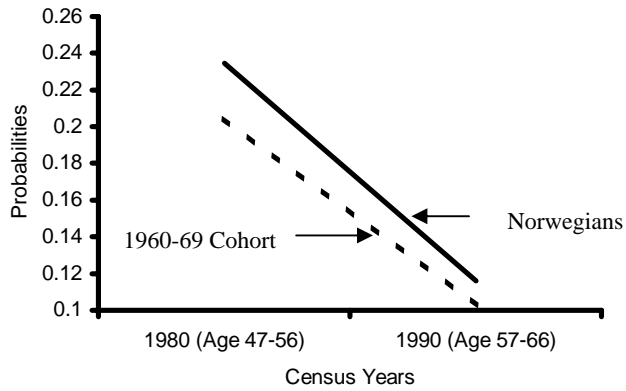


Figure 5. Overcrowding Propensities for Persons aged 47-56 in 1980

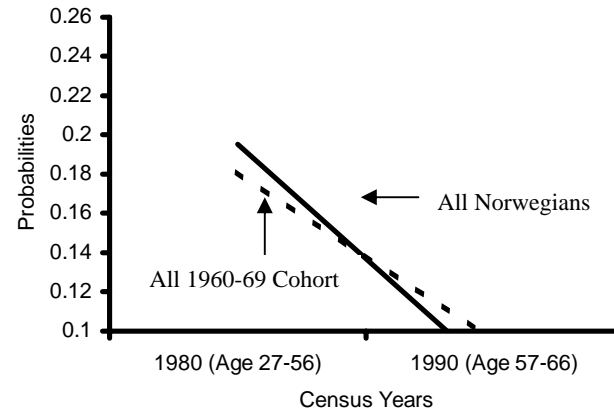


Figure 6. Overcrowding Propensities for Persons aged 27-56 in 1980 (Borjas Approach)

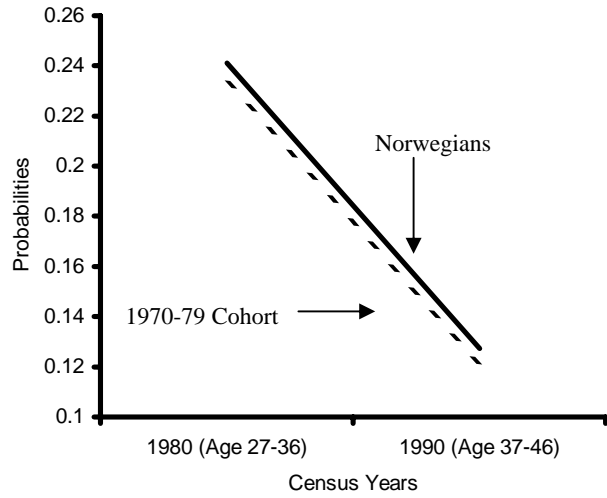


Figure 7. Overcrowding Propensities for Persons aged 37-36 in 1980

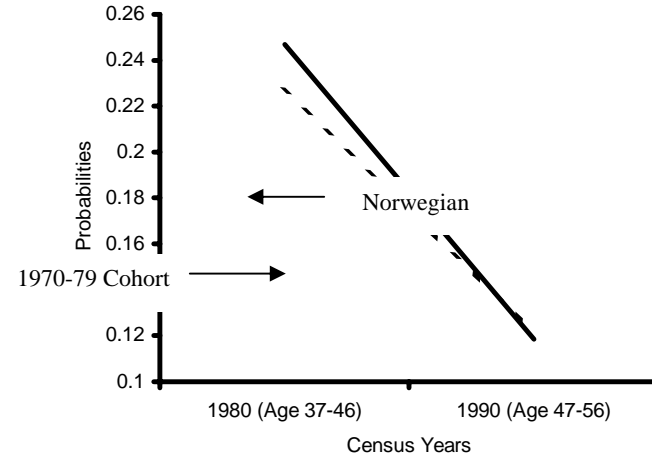


Figure 8. Overcrowding Propensities for Persons aged 37-36 in 1980

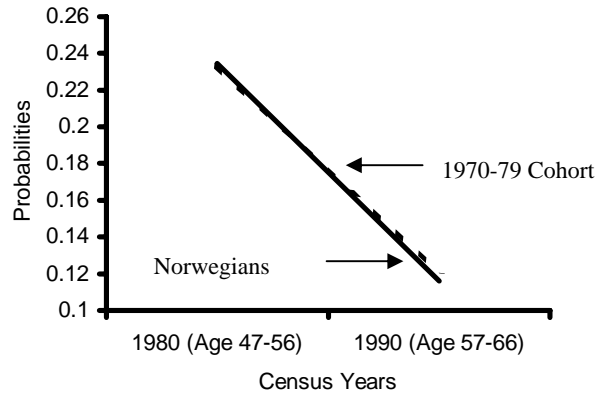


Figure 9. Overcrowding Propensities for Persons aged 47-56 in 1980

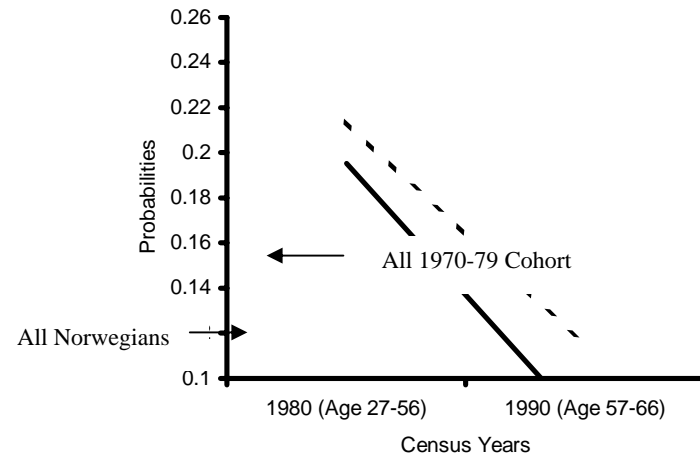


Figure 10. Overcrowding Propensities for Persons aged 27-56 in 1980 (Borjas Approach)

Table 5

The Distribution of Probability of Overcrowding by Arrival and Age Cohorts. 1980-1990

Census Years	Arrival Cohorts	Years Since Migration	Age Cohorts	Probability
1980	1970-1979	1-10 YRS	27-36	0.2327
	1970-1979	1-10 YRS	37-46	0.2280
	1970-1979	1-10 YRS	47-56	0.2334
	1960-1969	10-20 YRS	27-36	0.2036
	1960-1969	10-20 YRS	37-46	0.1996
	1960-1969	10-20 YRS	47-56	0.2045
	Norwegians		27-36	0.2411
	Norwegians		37-46	0.2469
	Norwegians		47-56	0.2345
1990	1980-1989	1-10 YRS	37-46	0.1643
	1980-1989	1-10 YRS	47-56	0.1627
	1980-1989	1-10 YRS	55-66	0.1615
	1970-1979	10-20 YRS	37-46	0.1219
	1970-1979	10-20 YRS	47-56	0.1206
	1970-1979	10-20 YRS	55-66	0.1197
	1960-1969	20-30 YRS	37-46	0.1048
	1960-1969	20-30 YRS	47-56	0.1037
	1960-1969	20-30 YRS	55-66	0.1029
	Norwegians		37-46	0.1272
	Norwegians		47-56	0.1184
	Norwegians		55-66	0.1161

Note: The probabilities were calculated using the following formula:

$$\hat{P}_{T,K,A} = \left\{ 1 + \exp \left[-(\bar{X}\hat{\beta}_T + \hat{\alpha}_K + \hat{\delta}_A) \right] \right\}^{-1}$$
 \hat{P} is the probability of overcrowding, $\hat{\beta}$, $\hat{\alpha}$ and $\hat{\delta}$ are the estimated coefficients taken from Table 3, and \bar{X} is a vector of specific individual-level characteristics. Note that $\hat{\alpha}_k = 0$ for Norwegians. The subscripts T = Census year, K = Year of arrival and A = Age cohort.