Motu

"Hometown & whānau, or big city & millennials?"

The economic geography of graduate destination choices in New Zealand

Arthur Grimes, Shaan Badenhorst, David C. Maré, Jacques Poot and Isabelle Sin

Motu Working Paper 20-04

Motu Economic and Public Policy Research

July 2020

National Science Challenges

BUILDING BETTER HOMES, TOWNS AND CITIES

Ko Ngā wā Kainga hei whakamāhorahora

Document information

Author contact details

Arthur Grimes

Motu Economic and Public Policy Research, and Victoria University of Wellington

arthur.grimes@motu.org.nz (contact author)

Shaan Badenhorst

Motu Economic and Public Policy Research, and Treasury

David C. Maré

Motu Economic and Public Policy Research

Jacques Poot

Vrije Universiteit Amsterdam, and University of Waikato

Isabelle Sin

Motu Economic and Public Policy Research

Acknowledgements

This project was funded by National Science Challenge 11: Building Better Homes, Towns and Cities.

Disclaimer

Access to the data used in this study was provided by Statistics New Zealand under conditions designed to give effect to the security and confidentiality provisions of the Statistics Act 1975. All frequency counts using Census data were subject to base three rounding in accordance with Statistics New Zealand's release policy for census data. The views, opinions, findings and conclusions or recommendations expressed in this paper are strictly those of the authors and do not necessarily represent, and should not be reported as, those of the organisations at which the authors are employed.

Motu Economic and Public Policy Research

PO Box 24390 info@motu.org.nz +64 4 9394250

Wellington www.motu.org.nz

New Zealand

 ISSN 1176-2667 (Print), ISSN 1177-9047 (Online).

Abstract

One of the main challenges facing non-metropolitan regions is the attraction and retention of highly-educated young people. A loss of the brightest can lead to reduced business creation, innovation, growth and community wellbeing in such regions. We use rich longitudinal microdata from New Zealand's integrated administrative data infrastructure to analyse the determinants and geography of the choice of destination of tertiary educated (university and polytechnic) graduates. We address the question of post-student location choice in the context of the approach of Chen and Rosenthal (2008) who introduced a methodology for calculating 'quality of life' and 'quality of business' indicators for urban areas reflecting consumption and productive amenities respectively. Specifically, we test whether students – of different characteristics (e.g. institutional type and field of study) – locate in places that are regarded as good to live or good to do business. Our estimates are conditional on students' prior school (home) location and the location of their higher education institution. We find that graduates are attracted to locate in places that have high quality production amenities. High quality consumption amenities have heterogeneous effects on the location choice of students. Creative Arts and Commerce graduates are relatively more likely to locate in places that are attractive to business, consistent with a symbiosis between bohemians and business. Places can leverage their existing (productive or consumption amenity) strengths to act as drawcards to recent graduates. The results are important for local decision-makers who wish to know which factors can attract and retain young qualified people.

JEL codes

I23, J24, J61, R23, R58, Z13

Keywords

higher education, human capital, graduate migration, networks, amenities, regional development

Summary haiku

productive places
attract our brightest young grads
good living may help

Executive summary

A highly-educated population is one of the key drivers of local growth and prosperity. One of the main challenges facing non-metropolitan regions is the attraction and retention of tertiary educated (university and polytechnic) graduates. A loss of bright young people can lead to reduced business creation, innovation, growth and community wellbeing. When there is no local university or polytechnic, regions will lose some of their youth who seek a tertiary education. The chance of students returning upon graduation and the chance of attracting other graduates will depend not only on the students' characteristics and where the tertiary education was undertaken, but also on how attractive a place is for graduates after studying.

We analyse a young person's choice of work location during their first years after graduation, given the location of their tertiary education and their prior home location. We investigate whether there are 'pull factors' that could encourage the graduates to return to home areas that they have left in order to pursue their studies. These pull factors include income-generating opportunities (e.g. jobs and wages) and the quality of life of a place.

Locational choices by workers and by firms are driven by many individual-specific and location-specific factors. We use indicators of overall 'quality of life' (QL) and overall 'quality of business' (QB) for 31 urban areas calculated in previous Motu work. QL reflects amenities in a location that impact directly on personal wellbeing (such as a pleasant climate) while QB reflects amenities that impact on firms' profitability (such as good infrastructure).

We use Stats NZ's IDI and population census data to follow young people from their school location to their place of tertiary study and then to their work locations over the first four years of their careers. We model their location choices based on personal characteristics, including their choice of field of study, and locations' QL and QB. We account for the distance between their home and workplace, and between their tertiary institution and workplace.

We find that graduates from all fields of study other than agriculture are attracted to locate in places that have high overall quality of business, which tend to be the large cities. High quality of life is also an attractor for some students but its impact is more diffuse than is the pull of income opportunities. Creative arts and commerce graduates are more likely to locate in places that are attractive to business, consistent with a symbiosis between 'bohemians' and business, as found elsewhere. An intriguing finding is that places can leverage their existing (productive and/or consumption amenity) strengths to act as drawcards to recent graduates. In other words, a place that is already good for business can concentrate on strengthening its business attributes to act as a greater drawcard for graduates, while a place that is already good to live in can concentrate on strengthening its liveability credentials. These results are important for local decision-makers who wish to leverage their local attributes to attract and retain young qualified people.

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1 Introduction

A highly-educated population is one of the key drivers of local growth and prosperity. One of the main challenges facing non-metropolitan regions is therefore the attraction and retention of tertiary educated (university and polytechnic) graduates. A loss of the brightest can lead to reduced business creation, innovation, growth and community wellbeing. When there is no local university or polytechnic, regions will lose at least for some years their youth who seek a tertiary education.[1] The chance of students returning upon graduation and the chance of attracting other graduates will depend on a range of 'pull factors', student characteristics, and where the tertiary education was undertaken. Some students may return to their home locality upon graduation, but others are likely to find work in the city in which the higher education institute (HEI)[2] is located. Alternatively, graduates may move to another large city, or go abroad.[3] The presence of an HEI, and especially a university, can itself contribute to population and employment growth in a region (Apatov and Grimes, 2019).

We analyse a young person's choice of work location during their first years after graduation, given the location of their tertiary education and the location of their prior schooling (i.e. home location). Our main interest is in the determinants of the location choice of where to work. Policy-makers in smaller settlements frequently bemoan the loss of their brightest young people. We investigate whether there are 'pull factors' that could encourage the graduates to return to such areas.

Locational choices by workers, and by firms, are driven by many individual-specific and location-specific factors. The available amenities data on cities and regions are unlikely to capture all relevant location features adequately. We therefore follow the approach of Chen and Rosenthal (2008) who calculate indicators of 'quality of life' (QL) and 'quality of business' (QB) for urban areas under the assumption that, in spatial equilibrium, local wages and rents reflect everything that matters locally for the utility of workers and for profits of firms. Spatial variation in wages and prices is then due to spatial variation in location-fixed amenities that

[1] While e-learning can in principle be a substitute for classroom learning, in practice most students continue to enrol in 'bricks and mortar' institutions. The evidence on the effectiveness of e-learning vis-à-vis classroom learning remains inconclusive (Bernard et al, 2004).

[2] We use the terms higher education institutions (HEIs) and tertiary institutions interchangeably to include both universities and polytechnics. For the latter, we include institutions labeled as polytechnics, institutes of technology and wānanga; a wānanga is a Māori-specific (i.e. indigenous) category of HEI. There are 8 universities and 19 polytechnics (including 3 wānanga) in New Zealand (Apatov and Grimes, 2019).

[3] Faggian et al. (2006, 2007) and Faggian and McCann (2009) created a typology of the various transitions that are possible. They characterise these as: *repeat migrants* (who move to the university region and upon graduation away from it, but not back home), *return migrants* (who move to the university region and return home upon graduation), *university stayers* (who move to the university region and stay there upon graduation), *late migrants* (who attend university in the home region and then migrate elsewhere) and *non-migrants* (who go to university in the home region and enter into full-time employment there as well).

impact on utility (such as a pleasant climate) or on profitability (such as good infrastructure). Following Roback (1982, 1988), it can be shown that a local increase in consumption amenities will lead to higher rents and lower wages, while greater production amenities will lead to higher rents and higher wages. Amenity-related wage and rent premiums are calculated as location-fixed effects in hedonic regression equations that account for observable determinants of wages and rents.

The empirical setting for our analysis is that of New Zealand. This country is of particular interest in the present context given that it has rich longitudinal microdata that can be derived from a set of integrated administrative datasets of individuals and firms, jointly referred to as the Integrated Data Infrastructure (IDI) collected and managed by Statistics New Zealand (Stats NZ).[4] New Zealand is highly urbanised (with 83 percent of the population living in urban areas) and has a high level of geographic mobility of skilled workers – including internationally.[5] We focus only on those who have remained within the country.

We use Stats NZ's IDI and population census data to follow young people who graduate and then reside in New Zealand in the early part of their careers. We link their choices with characteristics of local settlements and their personal characteristics, including their study choices. We account for the distance both between their home (i.e. where the person went to school) and workplace, and between their HEI and workplace.

Preston et al. (2018) and Grimes et al (2019) calculated wage and rent premia in 130 New Zealand urban areas using data from the eight population censuses since 1976. Following Chen and Rosenthal (2008), these premia were converted to a QL and QB for each urban area and year. We analyse the determinants of the destination choices of tertiary graduates, given their HEI location, by means of the alternative-specific mixed logit regression model (McFadden and Train, 2000), also referred to as the random-parameters model (Cameron and Trivedi, 2005). We test whether students of different characteristics (e.g. HEI type, field of study, HEI location, home location) locate in places that are regarded as good to live or good to do business. By incorporating prior school location we also test how the choice of work destination is affected by the pull of 'home'.

We find that graduates are attracted to locate in places that have high quality of business and, with greater herogeneity, high quality of life. Creative Arts and Commerce graduates are relatively more likely to locate in places that are attractive to business, consistent with a

[4] A description of the features and applications of the IDI can be found at https://www.stats.govt.nz/integrated-data/integrated-data-infrastructure/

[5] Ten years after study, about a third of young domestic university graduates live abroad (Ministry of Education, 2017).

symbiosis between bohemians and business (Florida, 2002). Creative Arts and Hospitality graduates appear to be more drawn to places with high consumption amenities than are other graduates. We find that places can leverage their existing (productive or consumption amenity) strengths to act as drawcards to recent graduates, consistent with the principle of comparative advantage. We also see a strong pull of home and of the HEI location for graduates over the first four years of their working life.

The next section reviews the literature on locational choices concerning tertiary education and the first job. Features of our data are described in section 3. We also briefly outline in that section how the QL and QB indicators are calculated (with more detail in an Appendix) together with our estimation strategy. Results are presented in section 4 while conclusions and policy implications are discussed in section 5.

2 Modelling graduate destination choices

2.1 Overview

Given that modern theories of regional growth assign considerable importance to education of the population as a driver of long-run growth (e.g., Mellander and Florida, 2019; Glaeser et al., 1995), a large literature has emerged during the last two decades concerning two pivotal decisions in the life of young people with academic aptitude: firstly, where to study given the home location, personal characteristics and what the available universities have to offer; and, secondly, where to work upon graduation. In this section we briefly review key contributions to the literatures on choice of location to study and the choice of where to work upon graduation. In our empirical work, we focus primarily on the latter, but we take the location of schooling into account as well. This allows us to test the 'pull' of home in the choice of where to work.

Prior to reviewing the empirical literature on location choice following graduation, we briefly place this choice in the context of a lifetime location choice model. Grimes et al. (2017) consider a theoretical model in which individuals choose their optimal post-study locations across two periods (early-adulthood and late-adulthood). Two potential locations are included: location A has high consumption amenity but low wages, while location B has low consumption amenity but high wages. Individuals differ according to their rate of time preference. The optimal time path for an individual with low rate of time preference is to situate initially in location B where they can earn high wages (which can be invested) and then to move to location A when older to enjoy high amenities. An individual with high rate of time preference chooses the opposite location pattern (i.e. enjoying life while young).

Ceteris paribus, individuals with a low rate of time preference are more likely to choose tertiary education than are those with a high rate of time preference given the delay in earnings received by those who study (compensated by higher earnings in later life). Thus theory predicts that tertiary students, on balance, will tend to locate initially in low consumption amenity but high wage places following graduation. We return to this prediction when discussing our empirical results.

2.2 Modelling the move from home to university

Those living in smaller urban areas and peripheral regions have no choice but to migrate for their tertiary education. Sá et al. (2004) provide a review of the economics of the selection of an HEI to study, and then proceed to estimate the determinants of flows of high school graduates to HEIs by means of a production-constrained gravity model. Using data from the Netherlands on flows of students from 30 regions of origin to 13 university regions of destination, Sá et al. (2004) find a strong distance deterrence effect: the larger the distance between the hometown and the university, the fewer the number of young people from the same hometown attending the university (see Lourenço and Sá, 2018, for similar evidence in Portugal). Suhonen (2014) shows with Finnish data that this distance deterrence effect also applies to specific fields: the further away from home a specific field is offered, the less likely it is selected. This result does not hold for all disciplines, notably medicine is an exception.

Sa et al. (2004) also find that high rents in university towns are a deterrent to studying there. On the other hand, amenities are a pull factor. A gravity model of inter-state migration for college attendance in the US (Dotzel, 2017) demonstrates similarly that natural amenities (such as a pleasant climate, the presence of mountains, and access to the sea) influence a young person's selection of a post-secondary institution. In work with Dutch microdata, Sá et al. (2006, 2012) find additionally important effects of a student's high school performance and a preference for attending the same university as their high school peers. Furthermore, male students and low-income students are likely to stay longer at home.

Behind the observed flows of students to universities and graduates to job are the decisions students need to make to select a preferred choice among a set of alternatives. Since McFadden (1974) these choices are thought of as being made in a probabilistic context, with the individual maximising a specific utility function that enables the choice process to be described by the multinominal logit or probit model. With a large sample of data on individuals, two alternative research designs are then possible: probabilistic choice modelling of individual choices or, alternatively, modelling the aggregate flows of individuals between origins and destinations that then satisfy a gravity model specification (for reviews, see: Cushing and Poot, 2004; Beine

et al., 2016; Poot et al., 2016). Given that we have access to detailed information on individuals through the IDI, we adopt the former approach. This approach is also more effective to test for heterogeneity in behaviour across selected sub-groups.

One of the key questions in the provision of tertiary education is whether an increase in the number and geographical spread of HEIs might reduce the 'brain drain' from non-metropolitan regions. Böckerman and Haapanen (2013) exploited HEI reform in Finland in the 1990s that transformed vocational colleges into degree-awarding polytechnics to investigate this. Using probit models of migration propensities, they found that the HEI reform increased participation in polytechnics substantially and that this led to higher interregional migration.[6] The greater mobility may have enhanced the efficiency of the labour market, but there was no evidence that it decreased the brain drain from less developed to metropolitan areas. Indeed, Kotavaara et al. (2018) find that small and declining university regions in Finland have difficulty in retaining university graduates. In any case they and Haapanen and Tervo (2012) find that geographic mobility rates in Finland are only high during the year of transitioning from university to the first job.

D'Agostino et al. (2019) find by means of a multilevel logit model that high school students from the south of Italy disproportionally move to universities in the centre and north of the country, with better post-study employment opportunities and higher income being important motivators – even though such migration involves a considerably greater distance than enrolment in a provincial university closer to home. Crescenzi et al. (2017) show that some of these students do return to homes in the south upon graduation, at least in the case of the economically lagging region of Sardinia, but because of family, social networks and quality of life rather than income.

Using cohorts of young people in Sweden at age 19, Berck et al. (2016) consider spatial sorting; they address the effects of selection into university by jointly modelling the choice of whether to enrol in university and where to be located at age 22. Using nested logit models they find that participation in university education is driven by school grades, with high income locations preferred for study. Students are attracted to more youthful places and also take family networks into account.

Graduates with a science, technology, engineering or mathematics (STEM) background have a greater impact on regional development than other graduates (e.g., Winters, 2014), so it is particularly useful to consider the choice of university for students with a STEM background. Gill et al. (2018) apply a conditional logit model to data on STEM students who started

[6] In contrast, Holdsworth (2009) found that HEI expansion in the United Kingdom led to less interregional student mobility.

university in 2011 in the United Kingdom. They find that such students are attracted to institutions with greater prestige, but distance from home is a deterrent to study-related migration. However, Ro et al. (2018) find that prestigious UK universities are less likely to attract students from poorer neighbourhoods and that when the latter attend prestigious institutions, they are less likely to study STEM subjects than their peers. Apparently, students from a poorer background have a lower willingness to pay for prestigious institutions (Walsh et al, 2019). However, the study by Sa et al. (2004) suggests that the role of prestige may be country-specific: in the Netherlands university academic quality is not a pull factor – perhaps because the quality variation across universities is relatively small there.

There is relatively little published research on what drives the choice of university in the New Zealand context. A stated preferences survey (n = 526) by Holdsworth and Nind (2006) draws conclusions that are similar to the evidence from other countries. They find that the available course options, employer recruitment from the university and the cost of the university education (including accommodation) are key factors that determine choices.

2.3 Modelling the move from university to early career employment

During the last decade, a large literature has analysed the destinations of university graduates, and the impacts of university-to-job transitions, with papers in edited volumes such as Faggian et al. (2017) and Corcoran and Faggian (2017) representing the kind of studies undertaken. The strong academic interest in graduate destinations is not surprising given that there has been in many countries an increasing concentration of university graduates in metropolitan areas (e.g., Costa and Kahn, 2000, in the US; Ahlin et al., 2014, for Sweden). This concentration has contributed to agglomeration advantages that have increased the prosperity of metropolitan areas (Berry and Glaeser, 2005; Glaeser, 2011), but it has also contributed to growing inequality within cities and across regions (see Alimi et al., 2018, for a literature review and New Zealand evidence). Contrary to public perception, the concentration of university graduates in central cities is not a new phenomenon driven by the preferences of Millennials for walkable and amenity-rich dense urban areas, but applies to earlier generations as well (Millsap, 2018).

Corcoran and Faggian (2017) note that graduates have high geographical mobility, particularly in the first few years after graduating. The determinants of the propensity to move can be classified under three main headings: *social* (personal and family background, networks), *spatial* (push and pull factors of the home, university and potential employment destination regions) and *professional* (level and field of study, academic performance).[7] Faggian et al. (2017) emphasize the importance of drawing on longitudinal data to better capture the spatial mobility

[7] See Rérat (2014) for a similar classification.

from school through university to the labour market. Many of the recent papers take this longitudinal approach. For example, Haussen and Uebelmesser (2018) use a longitudinal graduate survey of students in Germany who graduated in the 2004-05 year. The survey provides detailed work history for the first five years after graduation. Using a Heckman probit model they find that university-to-job and job-to-job transitions are linked to previous mobility, study excellence, fields of study, socio-economic characteristics and regional characteristics. Also focussing on German graduates, Teichert et al. (2018) use administrative social security records and event history / hazard rate methods to investigate graduate migration up to seven years after graduation. Over this period there is no effect of duration of stay on subsequent migration, but labour market contacts and social networks are important. Their results are broadly in line with those for Finland by Haapanen and Tervo (2012).

Comunian and Jewell (2018) use UK higher education student microdata to study the migration of graduates in creative disciplines in the UK from 6 months to 3.5 years after graduation. They find that the choice of discipline and mobility differences influence the ability of graduates to enter creative occupations. Creativity is expected to be influential in regional development (e.g., Mellander and Florida, 2019).

Marinelli (2013) finds (using multinomial probit models) with data on Italian graduates three years out of university that those who return from the university region to the home region had poorer academic performance while those who move onwards did academically better (but not as well as the stayers). Venhorst et al. (2010) uses microdata on Dutch HEI graduates to examine the relationship between ability, field of study and spatial mobility. For several disciplines, employers in peripheral areas of the Netherlands are able to retain the graduates with the highest grades. If graduates leave the region, those with the highest grades are more likely to go abroad. Venhorst et al. (2011) model the geographic mobility of Dutch university and college graduates by means of multinomial logit modelling and find that a large labour market is the main determinant of the retention of graduates. However, there are notable differences between college and university graduates (with the college graduates more affected by spatial differences in housing costs).

Taking a much longer perspective than the longitudinal studies reviewed above, Wielgoszewska (2018) analyses migration and social mobility of UK graduates by means of the 1970 British Cohort Study, comparing locations at age 16 and 42. Using logistic regressions, she finds a significant class distinction: with so-called escalator regions (university towns in peripheral areas) facilitating stability in the professional and managerial careers of the most privileged, while generating underemployment for those from less privileged backgrounds. Using data from the UK's Destination of Leavers of Higher Education surveys, Zwysen and Longhi (2018)

find that there is an ethnic dimension to these differences. For graduates in jobs six months after graduation, there are no earnings differences but finding employment is harder for graduates from ethnic minorities. However, differences in parental background, local area characteristics and university careers do contribute to persistent ethnic differences in earnings.

A recurring theme is the search for policy instruments that may encourage graduates to return to non-metropolitan areas or to encourage graduates to stay in escalator regions. Australian data show that the vast majority of graduates are retained by major cities but, given that most HEIs are in major cities, net migration of graduates is towards peripheral and rural areas (Corcoran et al., 2010). Haley (2018) uses logistic regression to identify the role of social space in Sweden that can assist in attracting the tertiary educated to rural areas. She finds that non-economic factors are important, but that there are significant gender differences in this respect. Imeraj et al. (2018) use linked census and register data for 1991-2010 in Belgium to examine the attractiveness and retention of higher education cities after students graduate. Using logistic and Cox regressions, they find that smaller cities have higher graduate retention rates, after controlling for other factors.

Using the multinomial logit model and the 2001 Canadian census to study location choices, Brown and Scott (2012) find that degree holders are more likely than non-degree holders to move to locations that are specialized in their industry, and they are willing to move longer distances. The role of amenities in degree holders' location choices appears to be secondary. Applying conditional and mixed logit modelling with data derived from a 1995 US survey of about 10,000 science and engineering graduates, Gottlieb and Joseph (2006) come to a similar conclusion. However, quality of life appears more important for those with doctorates. Using 1994-1999 migration data on 13 categories of US engineers, Scott (2010) concludes by means of fractional-response regressions that amenities only start to become important when approaching retirement. On the other hand, Whisler et al. (2008) find by means of US census data from 2000 and quality of life indicators that an abundance of cultural and recreational amenities lowers the out-migration rate of young college graduates. The older college-educated population is more attracted to safety and a milder climate. Buch et al. (2017) find in regression models of net migration in German cities that the highly-skilled respond to amenities such as sunshine and restaurants. Additionally, Buenstorf et al. (2016) analyse surveys of 2007-2009 German university graduates about one and a half years after graduation and find that graduates prefer employment in regions similar to where they grew up (after controlling for employment opportunities and distance).[8]

[8] See Krabel and Flöther (2014) for earlier Heckman probit modelling with the same German data.

As in the case in the choice of university, distance plays an important role in the choice of the location of first employment. Carree and Kronenberg (2014) consider the geometry of the triangle of place of study, place of work and place of residence for Dutch graduates one year after graduation. They find that the networks established in the place of study continue to matter: the commuting distance between work and residence is positively related to the distance between study and work, but negatively related to the distance between study and residence.[9] However, this Dutch study does not incorporate the important role of contact with parents and the 'home' region they live in. Dahl and Sorenson (2010) use Danish microdata on the locational choice of postgraduates in biological & physical sciences, engineering and medicine to quantify the importance of various types of contact. In some of their conditional and mixed logit regressions they control for self-selection bias by restricting estimation to the sample of those who select a new place of work because their former workplace closed. They find that these Danish technical workers value – in order of importance – proximity to: home (i.e. commuting distance), parents (but not siblings), high school class mates, college class mates, where they lived before, and income. The lesser role of income is consistent with the fact that, due to 'psychic costs', migration occurs far less commonly than spatial differences in income would suggest. In another Scandinavian study, Huttunen et al. (2018) similarly control for selection effects by focussing on displaced workers in Norway (by means of linked employer-employee data). They find that family ties and life events have a large influence on migration decisions following job loss and may be responsible for large income losses. Using a web-based survey with 2731 respondents in Saxony (in former East Germany), Kaplan et al. (2016) apply structural equation modelling to identify a huge role of social networks in migration decisions of young knowledge workers: leading to migration or staying intentions depending on where close friends and family are located.

Another recurring theme is the mismatch between skills and jobs in early career employment of university graduates. Case studies from Australia, Canada, Italy and the Netherlands are included in Corcoran and Faggian (2017). In the present context, mismatch can refer to qualification, field-of-study or skills. To some extent, such mismatch may be a temporary phenomenon that is resolved through job changes and labour mobility (e.g. Rosen, 1972), but it may be of a more lasting nature when there are informational asymmetries and discrimination (e.g. in the case of certain types of overseas migrants) or where mobility is impeded (e.g. for social reasons, such as caring for a relative). In this context, Abreu et al. (2015) use longitudinal data for 7060 UK graduates to explain, by means of mixed multinomial logit modelling, their

[9] The two-dimensional geometry of directed migration flows can also be studied with circular statistics. Faggian et al. (2013) use circular statistics and regression methods to show that UK university graduates target the most attractive employment places (where they are at an advantage), rather than employment places in general.

earnings and career satisfaction 3½ years after graduation, as a function of personal characteristics, type of university, course attended and subject studied, while controlling for the effects of a change in location or industry, given potential sample selection into this choice. They find that graduates who change location fare better than those who do not change location or industry. However, those who change both location and industry do worse in the short term, both in terms of lower earnings and lower career satisfaction. That migration reduces mismatch is also shown by Iammarino and Marinelli (2015) with survey data on Italian graduates of 2004 who are observed in 2007. However, the better post-migration education-job match is mostly achieved in the prosperous and efficient Northern regions of Italy. In the Netherlands, Venhorst and Cörvers (2018) find that internal migration of young graduates observed 18 months out of college or university appears to reduce education-job mismatch, as evidenced by the wage premium obtained through the migration. However, after controlling for self-selection by means of an instrumental variables (IV) approach, the internal migration effect is no longer statistically significant in most cases.

2.4 Modelling school-to-university and university-to-first-job movements jointly

There is a much smaller literature that links the choice of school to HEI with that of HEI to first job. Faggian and McCann (2009) analyse flows of students from domicile into university and flows of graduates into first employment jointly, based on the typology previously described in Faggian et al. (2006, 2007). They find that the distance travelled from domicile to university in Great Britain is on average greater than the distance travelled between the university and the first job. However, in the case of Scotland it is the opposite. The latter can be easily explained by a common pattern of those with a domicile in Scotland attending university in Scotland, but subsequently finding work in England. They also run regression models of the log odds of staying in the university region and find, inter alia, that the odds are smaller in less agglomerated regions and for non-white ethnicities. The attraction of large agglomerations for university students and graduates is also very clear in the analysis by Kooiman et al. (2018) of the spatial mobility of one birth cohort in the Netherlands, namely those born in 1979 who were observed between aged 16 and 35. They find that such spatial sorting of human capital investment and employment pays off in terms of wages. Venhorst (2013) also provides a descriptive account of home-to-HEI and HEI-to-work flows in the Netherlands and similarly finds net flows to core regions. However, he emphasizes that many graduates move back to familiar home regions (as long as these are close to the HEI).

Only a few studies consider life course mobility decisions as a simultaneous equations system. Ahlin et al. (2018) take this approach by formulating a binary response model with sample

selection. Their selection equation provides the marginal effects of explanatory variables on studying in an urban area while two outcome equations show the marginal effects of explanatory variables on working in an urban area conditioned on having studied in urban areas or not having studied in urban areas respectively. They use data on 16 cohorts of university graduates in Sweden and find significant spatial sorting by high school grades and educational level of parents. Basically, graduates with better high school grades and from families with a strong educational background are more likely to start their labour market careers in urban regions, even if they grew up and went to high school in rural regions.

Students may select a place of study with future employment opportunities in mind (Abreu et al., 2014). Bjerke and Mellander (2017) analyse Swedish microdata from 2001 to link the residential location of university graduates before they started university, i.e. the home region, with the place they live five years and ten years after graduation. Using multinomial logit regressions, they find that returning to the home region is driven by personal, not economic reasons (specifically: having children). There is little difference in results for five years or ten years after graduation.

While European papers have to date dominated the literature on home-to-university and university-to-job mobility, Kazakis and Faggian (2017) provide a case study for the US and Liu et al. (2017) and Ma et al. (2018) provide recent evidence on China and South Korea respectively. Kazakis and Faggian (2017) model the wage impact of the combined set of decisions regarding migration for study and migration for employment, using National Science Foundation microdata on US graduate scientists and engineers. They model selection by means of the multinomial treatment model developed by Deb and Trivedi (2006) and then estimate Mincerian earnings equations that include the estimated selection parameters. They find that repeat migration (i.e. home location to separate HEI location to separate subsequent location) is associated with higher average salaries, while late migration (i.e. identical home and HEI location and then a different location to work) is associated with a salary penalty.

Liu et al. (2017) draw on microdata from China (from the 2005 1% population sample survey) to investigate the migration from school to university to work for highly educated youths in China by means of two, independently rather than jointly, estimated conditional logit models. The choice of university is predominantly driven by the spatial distribution of supply, but with preference for the national key universities, irrespective of distance. The distribution of university graduates is driven by regional differences in wages. Ma et al. (2017) use the 1998–2010 Korean Labor and Income Panel Study (KLIPS) to study migration behavior of students and graduates in South Korea. They estimate a logit model of whether or not to migrate from the home region for university education and then insert the predicted probability as an additional

variable in a second logit model, namely the logit model that predicts whether to leave the university region to find the first job. They find that the probability of leaving the home region is positively affected by the quality of the university attended; and the higher the quality of the university, the greater the likelihood of further migration after graduation.

The papers reviewed above show that, besides population censuses and administrative data, another common source of data on destinations of graduates is generated by post-graduation surveys that universities or government agencies conduct to obtain better insight into the destinations of their graduates. In New Zealand, such surveys were compiled annually by the New Zealand Vice-Chancellors' Committee (now called Universities New Zealand – *Te Pōkai Tara*), but these surveys were cross-sectional (students were only interviewed once in the year following graduation) and were analysed only in simple descriptive terms. In 2011, a longitudinal survey (the Graduate Longitudinal Study New Zealand – GLSNZ, n = 8,719) was started (Tustin et al., 2012). Two and a half years after completing the baseline survey, about 70 percent of the respondents participated in the first follow-up survey. The second and third follow-up surveys are planned approximately five years and ten years after the baseline survey. Theodore et al. (2018) use the GLSNZ to find that Māori and Pacific employment outcomes were comparable with those of other New Zealand graduates at two years post-graduation, but Māori and Pacific graduates experienced significantly higher student debt burden and financial strain.

The IDI in New Zealand provides an alternative source of longitudinal data that links information on a person's home location and education with subsequent employment outcomes. This is the source of the data used in the present paper. There is only limited published New Zealand work on graduate destinations. Mahoney et al. (2013) use IDI data to find that five years after finishing study, the median earnings of young people who complete a bachelors degree is 53 percent above the national median earnings and that employment rates also increase with level of qualification gained. However, neither this research nor other research on destinations of New Zealand university graduates takes an explicit spatial perspective that considers how the outcomes are linked to the choice of the region in which to work.[10] Consequently, the present paper is the first to consider the spatial dimension of graduate destinations in the New Zealand context.

[10] There is some evidence that for those going abroad to study, a return to New Zealand pays off in terms of subsequent earnings (see Poot and Roskruge, 2013).

3 Description of data and estimation strategy

3.1 Data

We use Stats NZ's Integrated Data Infrastructure (IDI) and census data to identify graduates and map their movements over time. Our sample comprises domestic graduates who completed a qualification[11] in 2005 or 2012, and we utilise the corresponding quality of life and business measures created using 2006 and 2013 census data. Using education data, we identify the location of their HEI, which must have been attended intramurally. We also observe their high school, and therefore, 'home' location. We map the graduate's destination choice two and four years after graduation and identify whether this was an overseas destination, and if not, in which urban area of New Zealand they chose to live.

We restrict our sample to individuals who are observed to live in one of 31 main or secondary urban areas for all three possible locations: home, tertiary institute, and their destination (noting that destination is recorded separately for two and four years after graduation).[12] The top panel of Table 1 presents the total number of graduating students (for whom we have home location[13]) who are included in our final sample for each destination year (i.e. two and four years respectively after graduation). We observe that the majority of exclusions, especially for four years after graduating, occur due to international migration. There are also some exclusions due to rural areas[14] being either the home, HEI, or destination location.

The second panel of Table 1 outlines the composition of our final sample (which excludes students who migrate to other countries and those who move "rurally") in terms of the categories proposed by Faggian et al. (2006, 2007) and Faggian and McCann (2009). For each of two and four years after graduation, the largest category is *non-migrants*, i.e. students who do not leave the home region either to study or following graduation; this group comprises approximately 60% of the final sample (for both two and four years after graduation). The high level of urbanisation in New Zealand and the relative concentration of HEIs in large urban agglomerations contribute to the relatively large percentage of non-migrants. Only a small

[11] Qualifications must be level 4 or above, completed intramurally, full-time, start no more than one year following the completion of high school, and must involve contiguous study. The student must also be a domestic student and may not enrol in further full-time study within four years of completion of their 2005 or 2012 qualification. We include summer completions for each year. For example, a January 2006 completion is included as a 2005 completion.

[12] We include individuals in the 'two year' sample even if they are not observed in the fourth year after graduation, and include individuals in the 'four year' sample even if they are not observed in the second year after graduation; the latter case may be due to the individual travelling overseas in the intervening period.

[13] The 2012 full sample in Table 1 is larger than that for 2005 in part because of improved coverage of home (school) location within the administrative data through the sample period.

[14] "Rural' here refers to minor urban areas (small towns), genuinely rural areas, and unknown locations.

proportion of students study in their home region and then migrate (i.e. *late migrants*). Across these two categories, approximately two-thirds of students in our sample study at "home".

Of the students who study outside the home region (i.e. *return migrants*, *repeat migrants* and *tertiary stayers*), 66% stay in the HEI region two years after graduation, falling to 48% as the time from graduation extends to four years. A further sizeable proportion of those who studied away from home (25% after two years and 31% after four years) returns to the home region, again emphasising the strong pull of "home".

A potential concern for our analysis is any bias that the selection criteria may introduce. A demographic breakdown of the student samples is provided in Table 2. The table also provides breakdowns of the fields of study (FOS) of students across all HEIs, divided into 11 fields of study, plus a 'mixed' qualification category.

We observe that the demographic characteristics of the graduates in the final sample are consistent with the characteristics of the graduating sample. In a number of instances, we find that the final sample demographics reflect those of the full sample because of offsetting characteristics of the two excluded groups (i.e. those who move internationally and those who move rurally). For instance, university graduates are more likely to move internationally than are polytechnic students while the latter are more likely to move rurally. Similarly, natural and physical science graduates are over-represented in international movements and are under-represented in rural movements. By contrast, agricultural (and related) students are under-represented in international movements and strongly over-represented in rural movements.

Table 1. Sample Composition (number of graduates)

Graduation year	**2005**		**2012**	
Years after destination	**2**	**4**	**2**	**4**
Full Sample	10485	10485	17436	17436
- Rural Home, HEI, or Destination	1203	1164	2664	2478
- International Destination	1608	2715	2229	3402
Final Sample	**7674**	**6606**	**12543**	**11556**
Final sample comprises:				
Non migrants	5016	4209	7650	6756
Late migrants	351	498	408	753
Return migrants	480	549	1236	1308
Repeat migrants	198	387	381	837
Tertiary stayers	1629	957	2868	1899

Notes: *Non-migrants* study in the home region and stay there upon graduation; *late migrants* study in the home region and then migrate elsewhere; *return migrants* move to the study region and then return home; *repeat migrants* move to the study region then move away from it, but not back home; *tertiary stayers* move to the study region and stay there upon graduation. Any discrepancies in totals are due to random rounding to multiples of three.

Table 2. Demographic Characteristics of Samples

	Full Sample	International Movers	Rural Movers	Final Sample
Student's HEI Type				
University	75.1%	84.3%	67.4%	73.8%
Polytechnic	24.9%	15.7%	32.7%	26.2%
Gender				
Male	41.6%	40.9%	36.6%	42.9%
Female	58.4%	59.1%	63.5%	57.1%
Field of Study (NZSCED)				
Natural & Physical Sciences	12.6%	13.5%	12.1%	12.4%
Information Technology	2.5%	1.2%	2.2%	3.1%
Engineering & Related Technologies	5.9%	6.3%	4.8%	5.9%
Architecture & Building	3.3%	2.4%	3.9%	3.6%
Agriculture, Environmental & Related	1.3%	1.0%	4.2%	0.7%
Health	11.5%	11.6%	12.1%	11.4%
Education	5.5%	4.5%	7.8%	5.2%
Management & Commerce	18.0%	19.5%	14.8%	18.3%
Society & Culture	21.5%	22.7%	20.7%	21.2%
Creative Arts	12.6%	13.0%	11.5%	12.6%
Food, Hospitality & Personal Services	2.5%	2.1%	2.9%	2.5%
Mixed Field Programmes	2.8%	2.2%	2.8%	3.0%

Note that any discrepancies in totals are due to random rounding. The observations in the final sample are for the fourth year destination only.

The quality of life (QL) and quality of business (QB) measures that we use reflect the consumption and productive amenities respectively that are available in each location. We derive these measures formally in the Appendix following the approaches of Roback (1982), Gabriel and Rosenthal (2004) and Chen and Rosenthal (2008). The derivation shows that consumption amenities of a location (i.e. QL) can be proxied by a function of local rents minus local wages. Intuitively, within a spatial equilibrium framework (in which people can shift location to maximise their utility), a location with high rents but low wages must have consumption amenities that make it a nice place to live; otherwise people would move elsewhere and newcomers would not arrive. For instance, *ceteris paribus*, a sunny coastal location can pay lower wages and/or charge higher rents relative to a rainy, inland location.[15]

Similarly, the Appendix shows that productive amenities of a location (i.e. QB) can be proxied by a function of local rents plus local wages. Intuitively, a location with high rents and high wages must have highly productive amenities that boost firms' productivity otherwise firms would not locate in such a high cost location. Typically, cities with large populations experience agglomeration economies that enable firms to pay both high wages and high rents; yet many firms still choose to locate in these expensive locations because of the productive benefits of doing so.[16]

We report the 31 urban areas' QL and QB measures for 2006 and 2013 in Table A1 of the Appendix. QL & QB measures are standardised[17] to have a mean of zero and standard deviation of one. Figure 1 (sourced from Grimes et al., 2019) depicts the 2013 values of QL and QB for the 31 locations, where size of circle is proportional to population size.

Two features are immediately apparent from Figure 1. First, there is a strong negative correlation between locations' QL and QB values (the unweighted Pearson correlation coefficient r = -0.49 for 2013[18]). Second, locations with larger populations tend to be more productive (i.e. to have high QB) but to have lower QL. The higher QB for larger places is consistent with agglomeration economies in those locations (Maré and Graham, 2013). The lower QL in these places is consistent with a separate measure of quality of life derived from subjective wellbeing data. For instance, Morrison (2011) shows that residents in rural locations

[15] Hence the phrase "sunshine wages", sometimes used to describe low real wages in desirable locations.

[16] Preston et al., (2018) document patterns of consumption and productive amenities across locations in New Zealand corresponding to QL and QB for those locations. They find that places with larger populations tend to have higher QB (but lower QL) while places with high QL tend to be sunny, dry, near a body of water (i.e. the sea or a lake), and close to tourism facilities. There is also some evidence that places with high QL tend to have relatively high shares of the workforce engaged in education and health.

[17] Quality of life and business measures have been standardised across 130 urban areas and across all available census years, 1976-2013.

[18] Similarly, r=-0.50 for 2006.

and smaller towns in New Zealand record higher levels of life satisfaction than do residents of large cities such as Auckland.

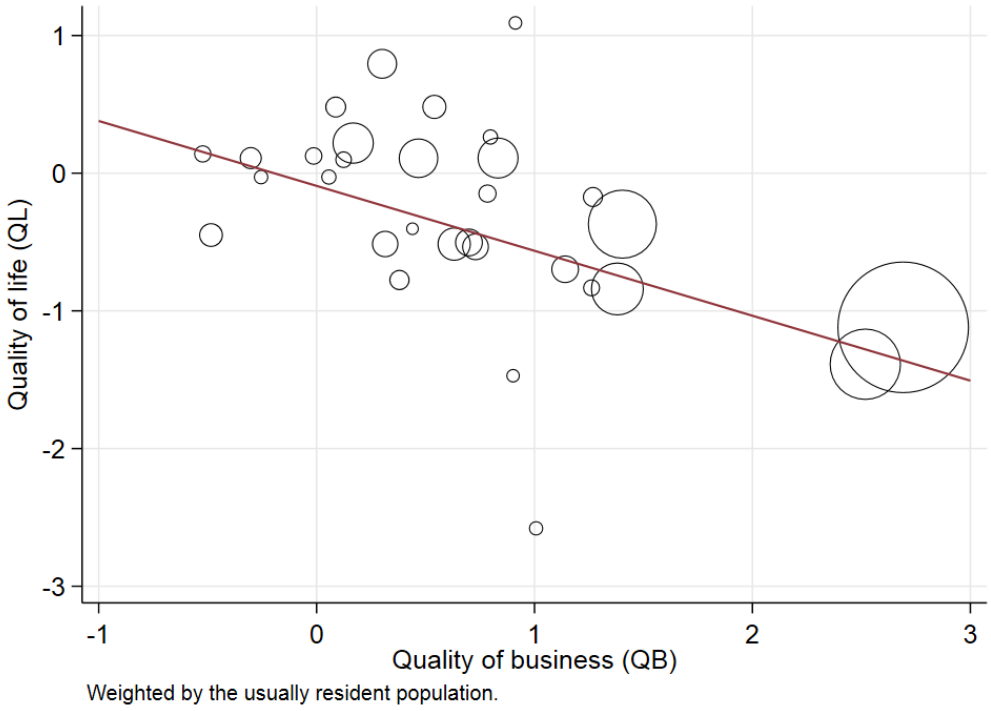


Figure 1. QL and QB values, 2013

Table 3. Quality of Life and Business, 31 main urban areas (2005 and 2012 graduates pooled)

	Quality of Life			Quality of Business		
Location	All	University	Polytechnic	All	University	Polytechnic
Home	-0.856	-0.883	-0.772	1.937	2.000	1.743
	(0.649)	(0.644)	(0.658)	(1.102)	(1.094)	(1.105)
HEI	-0.921	-0.950	-0.830	2.081	2.153	1.856
	(0.618)	(0.617)	(0.611)	(1.008)	(0.986)	(1.043)
Dest. Year 2	-0.893	-0.923	-0.800	2.027	2.099	1.805
	(0.642)	(0.637)	(0.650)	(1.033)	(1.011)	(1.067)
Dest. Year 4	-0.952	-0.992	-0.836	2.120	2.207	1.867
	(0.614)	(0.602)	(0.635)	(0.997)	(0.964)	(1.047)

Standard deviation in parenthesis. QL & QB measures are standardised to have a mean of zero and standard deviation of one.

Table 3 presents the mean and standard deviation of quality of life and quality of business for each of the four location categories broken down by student location and institution type (the

data are pooled across 2005 and 2012 graduates). We observe that university students grow up in slightly lower quality of life locations compared with polytechnic students. They also tend to grow up in places which are better for business. These outcomes likely reflect a greater prevalence of university students coming from the larger cities relative to polytechnic students. When comparing Home, HEI and Year 4 Destination, we observe that university students become even more concentrated in places with high quality of business. Polytechnic students similarly gravitate towards higher QB places to study but then experience no further progression (on average) in QB following study. This may be driven by the opportunities available to different types of student once they have completed their qualifications. Given that polytechnic students include those studying for trades qualifications, they are more likely to have suitable employment opportunities in the smaller New Zealand towns compared to university students who typically rely on the larger cities for work (Apatov and Grimes, 2019).

University students tend to migrate over time to areas with lower quality of life. This trend is consistent over time, except for the second year after graduation, suggesting that some individuals may be migrating home temporarily.

Figure 2 presents the mean quality of life and business measures for the final sample, highlighting the behaviour of graduates. We observe the transition, discussed above, towards a higher quality of business location over time, with a brief period of lower QB directly after graduating. The average quality of life decreases by 0.1 of a standard deviation, whereas quality of business increases by approximately 0.2 of a standard deviation between home and fourth year destinations.

Figure 2. Mean quality of life & business by location (all HEI graduates)

Appendix Figure A1 provides the same visual representation of location amenities over time by fields of study. We observe significant heterogeneity of location choices across the different fields, consistent with differing opportunities available to each field. For example, management and commerce students are relatively more likely to congregate in the high quality of business locations. From Table A1, the two top QB locations are Auckland, the largest city, and Wellington, the capital city. By contrast, agriculture and environment graduates are likely to remain in places with comparatively low QB which tend to be more rural in nature.

Figures 3 and 4 highlight the average differences between home and year 4 destination locations' QL and QB measures for graduates across all HEIs. For these figures, the zero category – being the category where individuals stay in their home location – is omitted so that the 'movers' can be seen clearly. The '-1' category is formally defined as [-1, 0) while the '1' category is (0,1], and similarly for the other categories in the graph. More than half of the individuals who experience a change are observed to lower their quality of life measure from home to destination, whereas close to two-thirds are observed to increase their quality of business measure. The magnitude of the changes indicates that a relatively small sacrifice in the quality of life measure does, on average, correspond to a material increase in the quality of business measure for those whose year 4 destination is not home.

Appendix Figure A2 provides the same representation for the transition from HEI to year 4 destination. Of those who move away from their HEI location, we see considerable

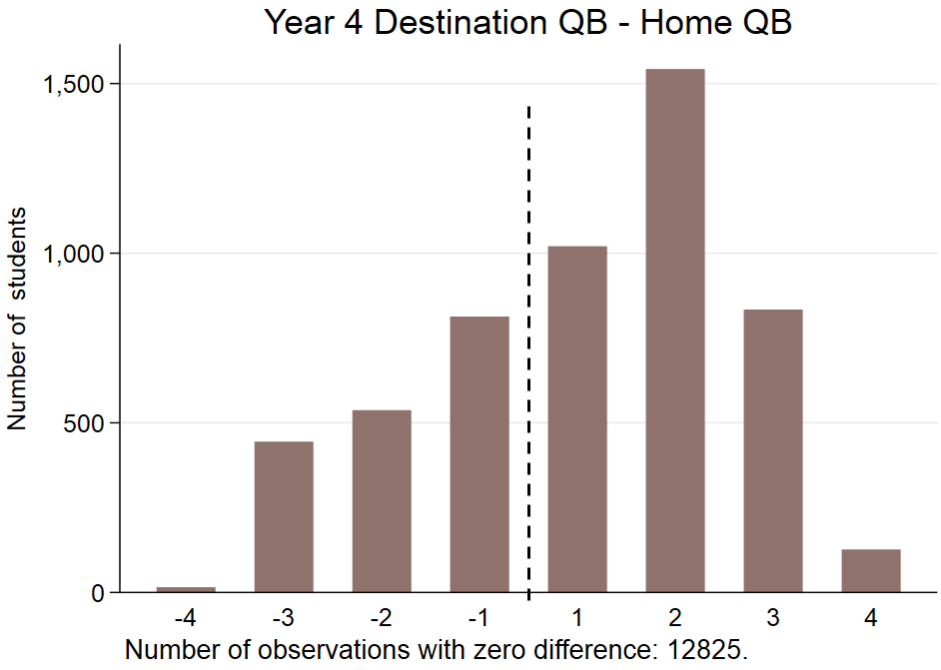
heterogeneity in movement both with respect to QL and QB. A slight majority of graduates experience a fall in QL through this transition, while QB transitions are almost evenly balanced. The relatively high proportion of people moving up three standard deviations in QB reflects graduates moving from low QB locations to either Auckland or Wellington.

Appendix Figures A3 and A4 decompose the movements from Home to year 4 destination and from HEI to year 4 destination by the institution type of graduates. The most marked differences occur with the move from HEI to year 4 destination (Figure A4). For this transition, university graduates have a much more pronounced move towards places with high quality of business than do polytechnic graduates.

Among the fields of study, we again observe a trend of graduates sacrificing quality of life for quality of business, but with significant heterogeneity in outcomes across the fields of study. Figures 5 and 6 present the differences in quality of life and business for home and year 4 destinations. We observe that management and commerce, creative arts, and engineering & technology students congregate in higher quality of business destinations. Agricultural students, on the other hand, choose destinations with comparatively low measures of (overall) quality of business, although it may well be the case that these locations are specifically attractive to agricultural business activities. Health graduates also, on average, locate in lower QB areas. Students in all fields of study are observed to transition upwards in terms of QB and downwards in terms of QL in the transition from home to year 4 destination.

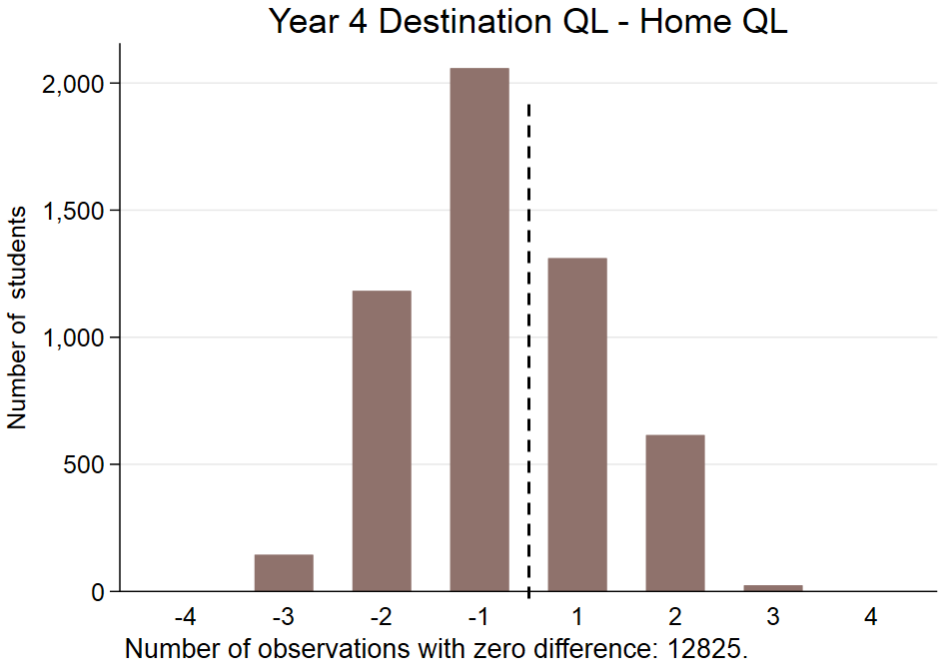
Figures 7 and 8 provide the equivalent representation for the transition from HEI to year 4 destination. Here we see heterogeneity in QL and QB transitions across fields of study, although most fields stay close to the 45° line signifying little change in access to consumption and productive amenities in their transition from HEI to year 4 location. Comparing Figures 7 and 8 with Figures 5 and 6 we see that the relatively large changes in QL and QB occur on average in the transition from Home to HEI and not in the transition from HEI to year 4 destination.

Figure 3. QB Transitions from Home to year 4 destination (all HEIs)



Note: The zero category is omitted so that 'movers' can be seen clearly. The '-1' category is defined as [-1, 0) while the '1' category is (0,1], and similarly for the other categories in the graph.

Figure 4. QL Transitions from Home to year 4 destination (all HEIs)



Note: See note to Figure 3.

Figure 5. QL by field of study for home and year 4 destination (all HEIs)

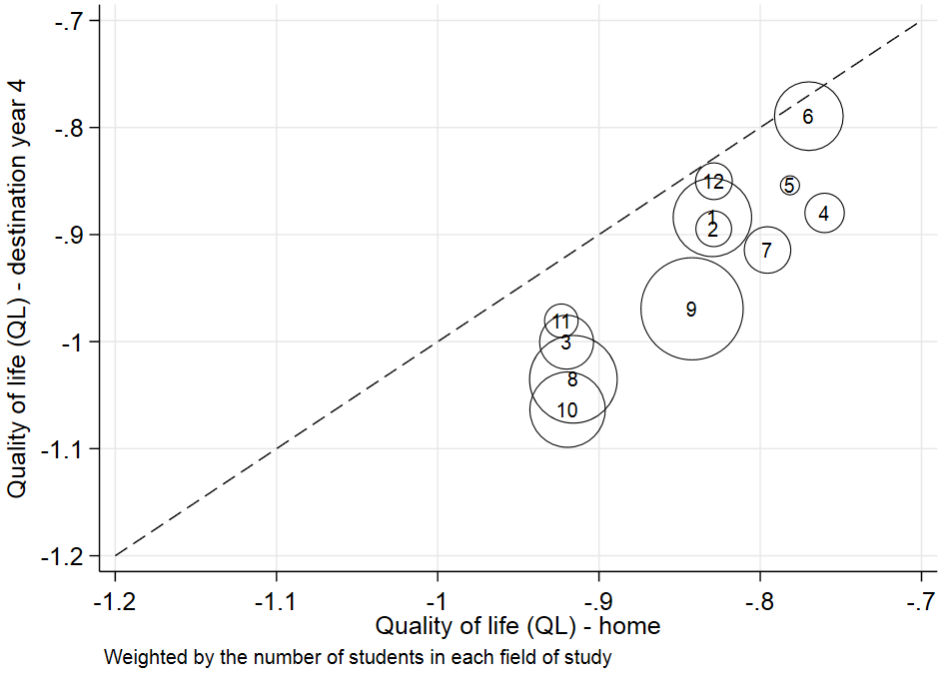


Figure 6. QB by field of study for home and year 4 destination (all HEIs)

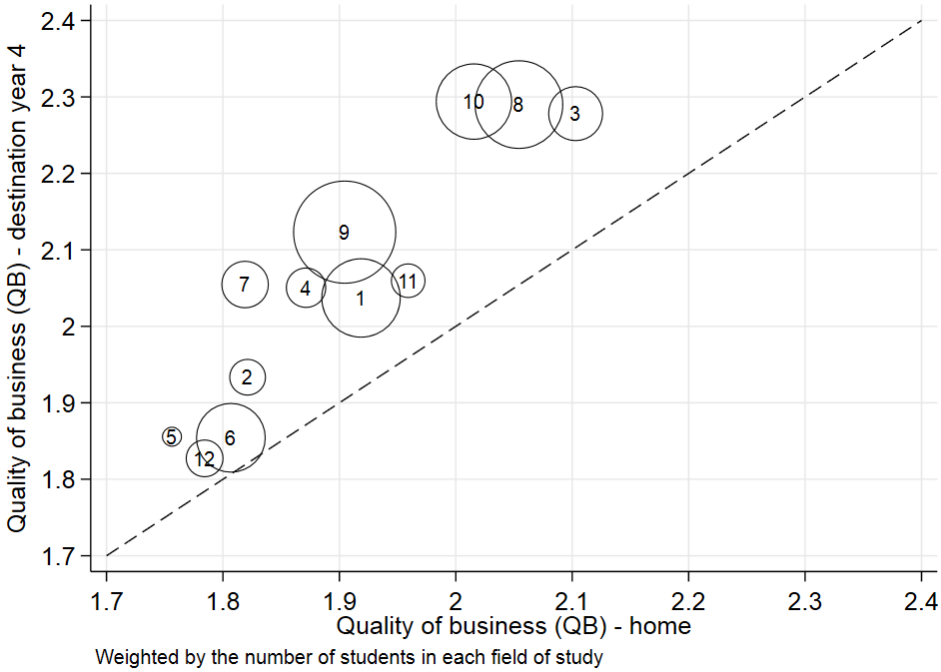


Figure 7. QL by field of study for HEI and year 4 destination

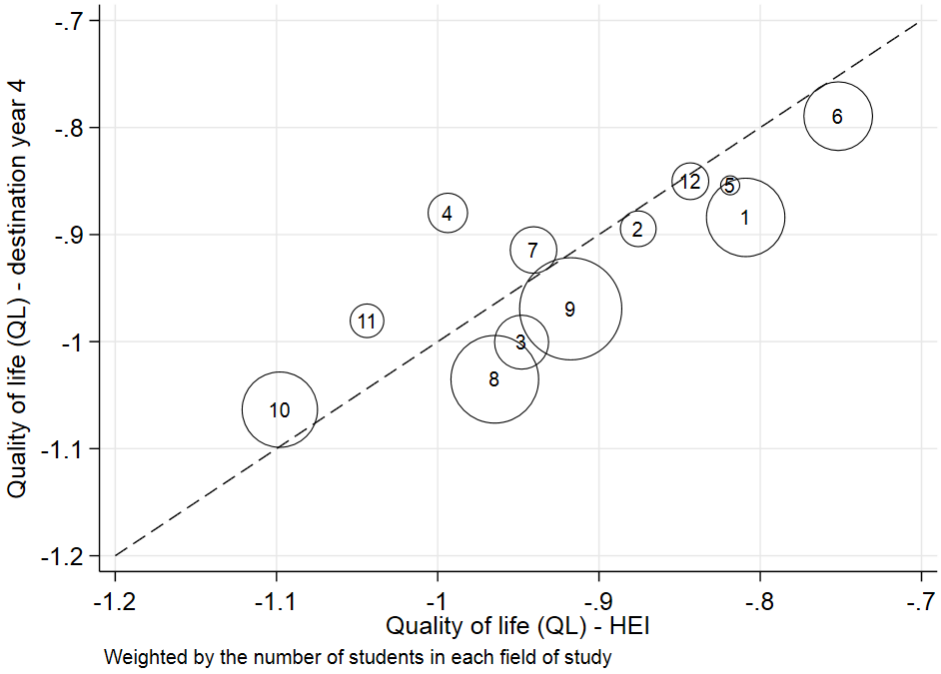
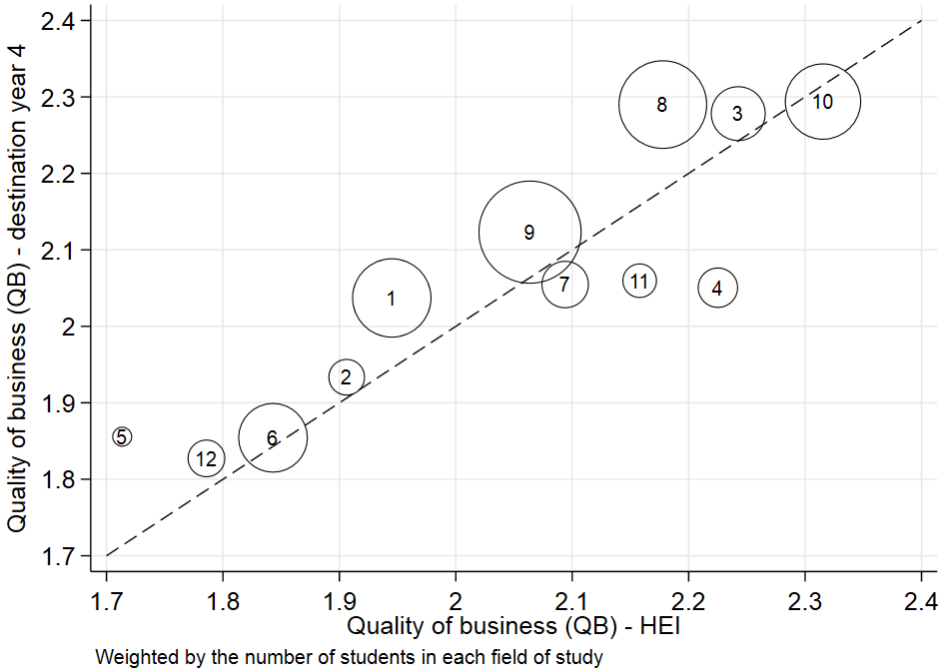


Figure 8. QB by field of study for HEI and year 4 destination



3.2 Estimation strategy

We begin our analysis with McFadden's (1973) conditional logit approach to model a choice from a discrete set of alternative destination locations (j = 1, …, J). In our case, the alternative destinations are the 31 main and secondary urban areas. Expected utilities are modelled in terms of the characteristics of the destinations, rather than the attributes of the individual graduates.[19] The utility derived by a representative graduate *i*, from alternative *j,* is given by:

$$U_{ij} = \beta' x_{ij} + e_{ij}$$

where β'represents a vector of coefficients, x_{ij} is a vector of observed location attributes which may vary by individual (for example, the distance from a potential destination to the individual's home location), and e_{ij} is a random error term which is assumed to be independent and identically distributed type 1 extreme value (Hole, 2007). The difference in errors between alternative j and base k follows a logistic distribution.

In our full specification, the vector of attributes (x_{ij}) for each of the 31 destinations ('Dest.') comprises:[20]

- *Dest. QL:* quality of life (QL) in dest. location;
- *Dest. QB:* quality of business (QB) in dest. location;
- *Dest. ln(population):* logarithm of population of dest. location;
- *Dest. Δln(population):* change in log population over prior intercensal period;
- *Dest. to home ln(distance):* logarithm of distance from dest. to home location;
- *Dest. to HEI ln(distance):* logarithm of distance from dest. to HEI location;
- *Dest. is home:* dummy variable (=1) if dest. is the same as home location;
- *Dest. is HEI:* dummy variable (=1) if dest. is the same as HEI location;
- *Dest. on home island:* dummy variable (=1) if dest. is on same island as home location[21];
- *Dest. on HEI island:* dummy variable (=1) if dest. is on same island as HEI location.

QL and QB are included to proxy for amenities that complement consumption and production respectively; population is included since each of QB and QL is correlated with city size so inclusion of population enables us to test whether any estimated QB and QL effects hold once we control for city size. It is possible that students are attracted to growing places (e.g. for job opportunities) or else are deterred from such cities which may have housing shortages or

[19] In some specifications, we relax the representative graduate assumption by allowing responses to vary by the student's institution type or field of study.

[20] Each of QL, QB and ln(population) are contemporaneous; ln(population) growth is over the previous inter-censal period.

[21] All our 31 urban areas are on either the North Island or the South Island of New Zealand.

location mis-matches within the city,[22] so we also include prior population growth as an explanatory variable to control for such influences.

We include six spatial terms in our estimation framework. The six variables comprise terms for the distance of the destination location from the home and HEI locations respectively, plus four dummy variables. The latter comprise dummies for the destination being the same place as the home or HEI location respectively, and for the destination being on the same island as the HEI or home location. We hypothesise that students are more likely to locate in their HEI or home location than other locations, and also be more likely to locate on the same island as their home or HEI locations, given past indications that a shift in island is viewed as being costly (Preston et al., 2018). In addition, we hypothesise that students will be attracted to locations that are nearer to their home or HEI location, hence inclusion of the distance variables. Inclusion of the dummy variables for home and HEI in addition to the distance variables reflects a hypothesis that there is a non-linear (step change) effect of locating away from the home or HEI position.

The validity of a conditional logit approach rests upon the assumption of independence of irrelevant alternatives (IIA), which in the context of location choices may be unrealistic as unobservable characteristics likely influence preference for locations (Grimes et al., 2017). To overcome the IIA restriction, we utilise a mixed logit model for our analysis which allows coefficients to vary across individuals (Train, 2009). By allowing some parameters in the model to be randomly distributed, a mixed logit model is effectively an extension of the conditional logit model. We assume a multivariate normal distribution for the random parameters so that the distribution parameters to be estimated are the means and standard deviations of each random coefficient.

To estimate a mixed logit model, simulation is required and this is computationally taxing. Given this computational challenge, and that our focus is on the quality of life and quality of business of the locations that can be chosen by individuals, we allow just the QL and QB coefficients to be random across individuals; the standard deviation coefficients are denoted '*SD Dest. QL*' and '*SD Dest. QB*' respectively.

[22] Grimes and Hyland (2015) show that housing stock changes lag behind population changes in New Zealand cities resulting in temporarily high housing costs in faster growing cities. Rents are included in our QL and QB measures but they may be temporarily out of equilibrium due to the lag in housing stock adjustments to population pressures. If this occurs, then QL and QB will also temporarily deviate from their equilibrium values which reflect local consumption and productive amenities.

When pooling students across all HEIs, we include a specification that contains interaction terms between each of the QL and QB measures and a dummy variable for polytechnic students to identify any differing behaviour by students according to institution type.[23]

The estimates that we present are based only on observable variables. We have also estimated an extended version in which we add place fixed effects that represent all unchanging unobservable aspects of each potential location. When we do so, these place fixed effects explain most of the variation in location choices with no significant explanatory power from QL or QB. This outcome is not surprising given that we have only two waves in our sample and each of QL and QB exhibit considerable path dependence. Given the long-lived property of amenities, which our QL and QB variables proxy, the place fixed effects capture the impact of these amenities which are our focus. Consequently, we restrict our attention solely to the estimates that exclude these place fixed effects. This means that we estimate the associations between location choices and observable place characteristics but we cannot be certain that these associations are necessarily causal.

All equations are estimated with respect to the destination choice four years after graduating. We concentrate on the four year gap since it allows students to take some time for 'trial and error' in finding an appropriate location, as observed in the preceding figures of movements two and four years after graduation.

4 Results

Table 4 reports the conditional logit and mixed logit regression coefficients for student movements from HEI to their destination four years after graduation. Column (1) reports the conditional logit estimates for a simple model that contains just population, population growth, QL and QB. Students are observed to be attracted to places with high population and high quality of business. Quality of life has no significant effect while students are deterred from moving to places with high recent population growth.

In column (2) we use the mixed logit model to estimate the same specification with random variation for the QL and QB terms. The standard deviation term for QL is significant indicating

[23] We also tested a specification that interacted a completion year dummy with all variables to test if our pooling across 2005 and 2012 cohorts is acceptable, and one that interacted a female dummy variable to highlight any differences in location preferences by gender. Neither set of interactions indicated material differences by year of completion or gender, and so are not reported.

that students respond in a heterogeneous manner to consumption amenities while there is little heterogeneity apparent with regard to productive amenities.

Columns (3) and (4) present our preferred specification, reporting conditional and mixed logit estimates respectively, with the spatial terms added. Column (5) extends the mixed logit specification to test if polytechnic students (represented using the interactive '*Polytechnic*' dummy variable) respond differently to university students with respect to QL and QB.

The results in columns (3) to (5) again indicate that graduates locate in places that have beneficial quality of business. This effect is weaker for polytechnic students than for university students. With the spatial terms added, quality of life is also found to be an attractor, with significant heterogeneity in response. By contrast, there is no significant heterogeneity in response to QB. The interaction terms indicate that the effect on student location choice of a one standard deviation change in QB relative to a one standard deviation change in QL is greater for university students than for polytechnic students.

The relative importance of QB relative to QL for university students is in keeping with the theoretical prediction (in section 2) that graduates are likely to choose high productive amenity places at the outset of their careers even if these places have lower quality of life. This prediction is conditional on the assumption that these graduates have lower rates of time preference than those who do not embark on tertiary study. The observed heterogeneity in responses may, in part, reflect heterogeneous rates of time preference across individual students.

In addition to these estimated responses to our main variables, we see that students are more likely to locate in larger places, in their home and HEI locations (and islands), and in places that are close to their HEI and to their home. These spatial responses are all as may be anticipated.

One possibly surprising result across all specifications is that recent population growth acts as a deterrent for student location choice. Places with recent fast population growth may face a temporary housing shortage which pushes up rents temporarily and/or forces new graduates to locate in unfavourable areas within a city. By construction, temporarily high rents will result in high values for both the QL and QB variables but this may not accurately reflect longer term equlibrium valuations placed on consumption and productive amenities which are what our QL and QB variables are designed to represent. The inclusion of lagged population growth potentially acts as a correction for this dynamic effect associated with temporarily high rents.

The significance of the polytechnic interaction term for QB in Table 4 raises the possibility that the responses of students from universities and polytechnics to other variables may differ across institution type. In Table 5, we present separate estimates for university and for

polytechnic students corresponding to columns (3) and (4) of Table 4. Once we do so, we find that university students retain greater responsiveness to both QL and QB than do polytechnic students. There are also some nuanced differences for other variables. For instance, while students from both types of institution are drawn to locate in larger places, this effect is more strongly observed for university students. University students are also more responsive to recent population growth than are polytechnic students.

Table 4. Pooled students – Destination Year 4

	(1)^	(2)	(3)^^	(4)	(5)
Dest. ln(population)	1.115***	1.148***	0.616***	0.663***	0.665***
	(0.016)	(0.018)	(0.022)	(0.023)	(0.023)
Dest. Δln(population)	-22.405***	-21.649***	-22.090***	-20.825***	-21.115***
	(1.694)	(1.706)	(2.608)	(2.735)	(2.741)
Dest. QL	0.048	-0.050	0.348***	0.220***	0.250***
	(0.033)	(0.034)	(0.045)	(0.042)	(0.047)
SD Dest. QL		0.472***		0.721***	0.722***
		(0.047)		(0.035)	(0.035)
Dest. QB	0.218***	0.157***	0.515***	0.434***	0.494***
	(0.035)	(0.035)	(0.045)	(0.045)	(0.047)
SD Dest. QB		0.007*		0.007	0.007
		(0.004)		(0.010)	(0.010)
Dest. to home ln(distance)			-0.085***	-0.087***	-0.087***
			(0.006)	(0.006)	(0.006)
Dest. to HEI ln(distance)			-0.060***	-0.060***	-0.059***
			(0.005)	(0.006)	(0.006)
Dest. is home			2.544***	2.613***	2.609***
			(0.039)	(0.041)	(0.041)
Dest. is HEI			2.443***	2.524***	2.506***
			(0.035)	(0.037)	(0.037)
Dest. on home island			0.073*	0.121***	0.114***
			(0.038)	(0.039)	(0.040)
Dest. on HEI island			0.471***	0.552***	0.568***
			(0.039)	(0.041)	(0.041)
Dest. QL * Polytechnic					-0.090
					(0.073)
Dest. QB * Polytechnic					-0.231***
					(0.041)
Observations	18162	18162	18162	18162	18162
Log likelihood	-35973.2	-35962.9	-16551.3	-16495.9	-16473.7

Model 1 & 3 are conditional logit models; models 2,4 & 5 are mixed logit models (regression coefficients reported in each case). Huber-White robust standard errors in parentheses; *p<0.1, **p<0.05, ***p <0.01. ^Psuedo r-squared = 0.423; ^^Psuedo R-squared = 0.735.

Table 5. University & Polytechnic Students – Destination Year 4

	University Students		Polytechnic Students	
	(1)^	(2)	(3)^^	(4)
Dest. ln(population)	0.679***	0.720***	0.471***	0.528***
	(0.026)	(0.027)	(0.042)	(0.043)
Dest. Δln(population)	-24.172***	-23.112***	-14.476***	-13.186**
	(2.985)	(3.109)	(5.461)	(5.769)
Dest. QL	0.408***	0.258***	0.182**	0.147*
	(0.053)	(0.052)	(0.086)	(0.077)
SD Dest. QL		0.679***		0.772***
		(0.045)		(0.061)
Dest. QB	0.533***	0.446***	0.419***	0.369***
	(0.053)	(0.054)	(0.088)	(0.088)
SD Dest. QB		0.008		-0.010
		(0.011)		(0.035)
Dest. to home ln(distance)	-0.090***	-0.091***	-0.060***	-0.061***
	(0.006)	(0.007)	(0.013)	(0.014)
Dest. to HEI ln(distance)	-0.061***	-0.060***	-0.057***	-0.063***
	(0.006)	(0.006)	(0.012)	(0.013)
Dest. is home	2.442***	2.496***	2.844***	2.926***
	(0.046)	(0.048)	(0.078)	(0.080)
Dest. is HEI	2.465***	2.525***	2.216***	2.339***
	(0.041)	(0.043)	(0.078)	(0.082)
Dest. on home island	0.072*	0.115***	0.093	0.147
	(0.041)	(0.043)	(0.098)	(0.102)
Dest. on HEI island	0.406***	0.487***	0.704***	0.778***
	(0.043)	(0.045)	(0.095)	(0.100)
Observations	13512	13512	4653	4653
Log likelihood	-12657.4	-12628.0	-3817.1	-3796.1

Model 1 & 3 are conditional logit models; models 2 & 4 are mixed logit models (regression coefficients reported in each case). Huber-White robust standard errors in parentheses; *p<0.1, **p<0.05, ***p <0.01. ^Psuedo r-squared = 0.727; ^^Psuedo R-squared = 0.761.

As well as responses to QL and QB differing between university and polytechnic students, it is quite possible that responses to consumption and productive amenities differ by field of study. To explore this potential heterogeneity in response, we estimate specifications that allow for different responses for students from different fields of study (FOS). We base our estimates of these relationships on the specification in column (4) of Table 4, with two added terms in which we interact a specific FOS with each of QL and QB. Results are reported in Table 6. Each row of Table 6 reports results for the impacts of QL and QB for a particular (i.e. separate) FOS equation.

The first two columns report the coefficient on the interaction term between each FOS and QL and QB respectively. The interaction term indicates how the QL and QB responses for that FOS differ from the average for all other fields. Other than the 'Mixed' category, no FOS differs significantly from the others in terms of its reaction to QL. Consistent with intuition, however, the point estimates suggest that Creative Arts and Hospitality graduates are more attracted to places with high quality of life than are graduates from other disciplines.

With respect to QB, we find that graduates from two fields are less attracted to places with high quality of business than are other graduates. Health graduates are likely to be required throughout the country so a high quality of business is not a particular drawcard for these students. Graduates in the Agriculture and Environmental fields are likely to situate in smaller communities servicing rural needs. As shown in Figure 1, smaller communities tend to have lower overall quality of business (although they are likely to be better suited to agricultural servicing activities).

Commerce graduates are more likely than the average to locate in places with high quality of business, consistent with agglomeration economies for these graduates given that larger commerce-oriented cities tend to have high QB. Creative Arts graduates are also more likely to locate in such places, potentially reflecting the types of synergies between business and the arts discussed by Florida (2002).

When we consider the combined coefficients that show the full effect for each of QL and QB (columns (3) and (4) respectively of Table 6), we find that Quality of Life is an attractor for graduates in the Sciences, Architecture, Education, Commerce, Society, Creative Arts, and Hospitality (plus Mixed). Quality of Business is an attractor for graduates from all fields of study other than Agriculture/Environment (again noting that these graduates are likely to be attracted to places with business environments that are specifically suited to these fields). Consistent with our heterogeneity results in Tables 4 and 5, we therefore again observe greater heterogeneity of response with respect to QL than we do with respect to QB. Quality of Business is an almost ubiquitous attractor for graduates whereas the location response to Quality of Life differs more markedly across fields of study.

We gain greater insights into the relative importance of consumption and productive amenities by calculating the marginal effects of a one standard deviation change in each of QL and QB on the probability of locating in each city. The marginal effects are derived using our preferred (aggregated) specification, column (4) of Table 4. We calculate the marginal effect by perturbing the QL or QB of a randomly selected urban area for each individual and calculate the change in the probability of the individual choosing that urban area. The calculation takes into account the heterogeneity associated with QL and QB and also takes account of each student's own

circumstances (e.g. distance of each city from the student's home, HEI, etc); it also accounts for the non-linearity of the specification.

Table 6. QL and QB responses by Field of Study (FOS) – Destination Year 4

Field of study (FOS)	QL*FOS	QB*FOS	QL + QL*FOS	QB + QB*FOS
Sciences	0.083	-0.073	0.289***	0.372***
	(0.078)	(0.047)	(0.074)	(0.058)
IT	-0.203	-0.107	0.024	0.330***
	(0.168)	(0.100)	(0.168)	(0.107)
Engineering	-0.122	-0.010	0.106	0.425***
	(0.146)	(0.085)	(0.145)	(0.092)
Architecture	0.290	0.046	0.501*	0.478***
	(0.183)	(0.109)	(0.182)	(0.114)
Agriculture/Environmental	-0.173	-0.332**	0.050	0.106
	(0.298)	(0.150)	(0.298)	(0.155)
Health	-0.132	-0.325***	0.109	0.152**
	(0.086)	(0.051)	(0.082)	(0.063)
Education	0.040	-0.066	0.259*	0.371***
	(0.156)	(0.091)	(0.155)	(0.098)
Commerce	0.043	0.314***	0.262***	0.705***
	(0.091)	(0.054)	(0.089)	(0.065)
Society	-0.108	0.012	0.137*	0.441***
	(0.079)	(0.045)	(0.076)	(0.058)
Creative Arts	0.152	0.199***	0.356***	0.609***
	(0.116)	(0.067)	(0.115)	(0.077)
Hospitality	0.217	-0.090	0.433*	0.346**
	(0.246)	(0.130)	(0.245)	(0.136)
Mixed	0.321*	-0.050	0.531***	0.383***
	(0.170)	(0.109)	(0.168)	(0.114)

Each row represents a separate equation in which a single FOS is entered along with the base equation [eqn (2) of Table 5]; each equation includes all variables in the base equation (not reported). QL*FOS & QB*FOS regression coefficients represent the difference in QL & QB for that FOS relative to all other fields. QL + QL*FOS and QB + QB*FOS is the linear combination of the base QL and QB regression coefficient and the FOS interaction term with QL or QB.
Huber-White robust standard errors in parentheses; *p<0.1, **p<0.05, ***p <0.01.

Table 7 reports the (percentage point) marginal effects (plus standard errors) for each location with respect to a one standard deviation change in QL or QB. QB has a significant effect on student location choice for all cities, while QL has no significant effect for any location. The latter result reflects the estimated heterogeneity in preferences with respect to consumption amenities. If students are locating on the basis of prospective jobs and incomes (i.e. with respect to QB) it is reasonable to consider that there will be little heterogeneity with respect to the effect of productive amenities (except, perhaps, for the small number of graduates in the

Agriculture/Environment field, as observed in Table 6). By contrast, tastes with respect to consumption amenities may differ widely across students. Thus a rise in QB is likely to have a similar effect on location choice for different types of students whereas there is less predictability about whether any particular student will be attracted to a specific bundle of consumption amenities in different locations.

Table 7. Marginal effects of a 1 SD change in QL and QB on (percentage point) probability of locating in city

	Quality of Life		Quality of Business	
	Marginal Effect	Standard Error	Marginal Effect	Standard Error
Whangarei	0.303	0.396	0.232***	0.017
Auckland	3.377	6.741	3.138***	0.364
Hamilton	0.879	1.515	0.875***	0.096
Tauranga	1.046	1.737	0.458***	0.036
Rotorua	0.355	0.469	0.272***	0.021
Gisborne	0.278	0.437	0.156***	0.007
Napier-Hastings	1.089	1.864	0.527***	0.034
New Plymouth	0.327	0.467	0.277***	0.025
Wanganui	0.198	0.260	0.121***	0.001
Palmerston North	0.578	0.790	0.470***	0.040
Wellington	1.406	3.502	1.862***	0.242
Nelson	0.972	2.320	0.349***	0.027
Christchurch	1.607	2.664	1.355***	0.154
Dunedin	1.455	2.241	0.960***	0.092
Invercargill	0.224	0.339	0.186***	0.014
Kapiti	0.745	1.896	0.222***	0.012
Blenheim	0.442	0.914	0.166***	0.009
Pukekohe	0.201	0.286	0.109***	0.010
Tokoroa	-0.056	0.973	0.117***	0.008
Taupo	0.256	0.382	0.124***	0.009
Whakatane	0.262	0.427	0.111***	0.005
Hawera	0.020	0.127	0.068***	0.005
Feilding	0.143	0.214	0.070***	0.003
Levin	0.199	0.340	0.081***	0.001
Masterton	0.247	0.420	0.114***	0.005
Greymouth	0.089	0.137	0.058***	0.003
Ashburton	0.063	0.103	0.069***	0.006
Timaru	0.111	0.183	0.124***	0.008
Oamaru	0.129	0.208	0.065***	0.002
Rangiora	0.174	0.304	0.075***	0.006
Queenstown	0.428	1.306	0.118***	0.013
Overall	**0.569**	**1.053**	**0.420*** **	**0.041**

Standard errors are derived from 100 random draws for each of the QL and QB coefficients to calculate the marginal effect of a one standard deviation increase in each measure, ceteris paribus. The overall marginal effect for each of QL and QB is the average of all the changes in probabilities across all the randomly selected urban areas.

Despite the insignificance of QL due to this heterogeneity in tastes, we observe that the point estimate for the overall QL marginal effect is, on average, slightly larger than that for QB. We also observe that the relative size of marginal effect for QL versus QB varies widely across cities. For instance, in Wellington, a change in QB has a greater marginal effect on its attractiveness to graduates than does a commensurate change in QL. In most other cities, the point estimate of the marginal effect from a QL change is greater than that for a QB change (albeit calculated with considerably less precision).

Another clear distinction is related to city size. For instance, the marginal effect of QL for Auckland is over 12 times that for Whangarei, while for QB the ratio is 17. These differences according to size are to be expected given that Auckland's population is much larger than that of Whangarei; hence there will be a greater extra flow of students to Auckland than to Whangarei following a commensurate change in QL or QB.

In order to abstract from this population size effect, Table 8 presents the estimated marginal effect for each city (columns (1) and (2) in the table[24]) as a proportion of its usually resident population (URP; column (3) in Table 8) in 2013. While the absolute population-adjusted figures in the final two columns are not easily interpretable, the relative sizes are illuminating. The marginal effects relative to population size in the major cities tend to be lower than in smaller places. Given that the large cities have tertiary institutions (including universities) this result is as expected since many students stay in the same place as their HEI location and so their location choice is less driven by productive and consumption amenities.

Smaller places that are relatively good for business, such as Tokoroa (see Appendix Table A1), have a large population-adjusted marginal effect for QB, whereas places with poorer QB (such as Levin) have a comparatively low population-adjusted QB effect. Places that have highly rated consumption amenities such as Nelson and (especially) Queenstown have a large population-adjusted marginal effect for QL relative to places with poor existing QL (e.g. Tokoroa or Hawera). Thus, the results are consistent with the principle of comparative advantage: Places that are good for business increase their attractiveness to graduates further by enhancing the business environment while places that are good to live in become more attractive by enhancing their consumption amenities.

[24] Columns (1) and (2) of Table 8 are expressed as changes in probabilities rather than in percentage point terms and so the coefficients are one percent of those in columns (1) and (3) of Table 7.

Table 8. Population adjusted marginal effects

	Marginal effect (ME)		Population	Ratio of ME to URP	
	QL	QB	(URP, mill)	QL/URP	QB/URP
Whangarei	0.00303	0.00232	0.04917	0.06159	0.04719
Auckland	0.03377	0.03138	1.30883	0.02580	0.02398
Hamilton	0.00879	0.00875	0.20345	0.04322	0.04301
Tauranga	0.01046	0.00458	0.12041	0.08683	0.03804
Rotorua	0.00355	0.00272	0.05327	0.06667	0.05106
Gisborne	0.00278	0.00156	0.03269	0.08511	0.04772
Napier-Hastings	0.01089	0.00527	0.12222	0.08911	0.04312
New Plymouth	0.00327	0.00277	0.05269	0.06204	0.05258
Wanganui	0.00198	0.00121	0.03809	0.05205	0.03177
Palmerston North	0.00578	0.00470	0.07820	0.07397	0.06010
Wellington	0.01406	0.01862	0.37713	0.03729	0.04937
Nelson	0.00972	0.00349	0.06056	0.16055	0.05763
Christchurch	0.01607	0.01355	0.35335	0.04548	0.03835
Dunedin	0.01455	0.00960	0.11202	0.12989	0.08570
Invercargill	0.00224	0.00186	0.04790	0.04679	0.03883
Kapiti	0.00745	0.00222	0.03950	0.18861	0.05621
Blenheim	0.00442	0.00166	0.02930	0.15095	0.05666
Pukekohe	0.00201	0.00109	0.02653	0.07577	0.04109
Tokoroa	-0.00056	0.00117	0.01271	-0.04395	0.09202
Taupo	0.00256	0.00124	0.02186	0.11728	0.05671
Whakatane	0.00262	0.00111	0.01793	0.14585	0.06189
Hawera	0.00020	0.00068	0.01122	0.01824	0.06061
Feilding	0.00143	0.00070	0.01482	0.09646	0.04722
Levin	0.00199	0.00081	0.01944	0.10242	0.04167
Masterton	0.00247	0.00114	0.02010	0.12310	0.05672
Greymouth	0.00089	0.00058	0.00966	0.09263	0.06004
Ashburton	0.00063	0.00069	0.01847	0.03436	0.03736
Timaru	0.00111	0.00124	0.02705	0.04093	0.04584
Oamaru	0.00129	0.00065	0.01305	0.09910	0.04982
Rangiora	0.00174	0.00075	0.01502	0.11589	0.04994
Queenstown	0.00428	0.00118	0.01150	0.37171	0.10259

Note: The marginal effect is expressed in terms of the raw probability (rather than in percentage points).

5 Conclusions

We analyse the within-country location choice of HEI graduates in New Zealand following their studies. Specifically, we focus on the movements of graduates whose home, HEI and destination four years after graduation are each within the 31 main and secondary urban areas of New Zealand. The estimation sample comprises over 18,000 students out of two graduating cohorts. We also report descriptive statistics summarising destination choices of graduates two years after graduation.

We bring together the literature on graduate location choice with that on locational amenity values. These locational amenities are measured using the 'quality of life' (QL) and 'quality of business' (QB) metrics arising from the work of Roback (1982), Gabriel and Rosenthal (2004) and Chen and Rosenthal (2008). A place with high quality of life has beneficial consumption amenities, so residents are prepared to accept high rents and/or low wages. A place with high quality of business has beneficial productive amenities, so firms are prepared to pay high rents and high wages.

At a descriptive level, we find that students tend to move from home to HEI to fourth year destination on a gradient of falling quality of life and rising quality of business. The negative correlation between the two quality measures reflects the findings of Morrison (2011) and Preston et al. (2018) that larger cities have lower quality of life, perhaps because of congestion, while enjoying agglomeration benefits (Maré and Graham, 2013).

The trajectory of graduate migration reflects one of a drift towards the larger settlements. One slight interruption to this pattern is that graduates tend to revert two years after graduation to lower QB and higher QL places relative to their HEI, before their longer term location choice favours places that are better for business. The direction of movement to a higher quality of business location from home to fourth year destination occurs, on average, for students across all fields of study, though the direction of movement differs between HEI and destination reflecting different skill demands in different places.

In modelling the relationship between graduates' destination choices and locations' QL and QB we confirm the positive association of graduate destination choice with the locational quality of business, with very little heterogeneity of response. We also find that a higher quality of life helps to attract graduates to a place, but the response to quality of life displays considerable heterogeneity across graduates. The effects of each type of amenity are stronger for university graduates than for those from polytechnics. We also find a strong pull of home for many students, plus a pull to remain in the chosen HEI destination, while a larger population also acts

as an attractor. By contrast, graduates are less likely to locate in places that have had recent high population growth, possibly reflecting temporary housing constraints.

Relative to other graduates, those with Management and Commerce qualifications are attracted to places with a high quality of business while Creative Arts graduates are attracted both to places with high quality of business and high quality of life. Artistic graduates' attraction to places with high QL may reflect the preferences of those who study in the creative arts. The attraction of both Creative Arts and Commerce graduates to places with high QB is consistent with the beneficial effects for cities that mix bohemian and business elements (Florida, 2002).

Our estimates indicate that places with already high quality of business are the places that would benefit most in terms of graduate location choice through further increases in productive amenities, while those with already high quality of life would benefit most through further increases in consumption amenities. Thus our results are consistent with the principle of comparative advantage in which places can leverage their existing strengths in order to act as drawcards for recent graduates.

Our results for graduates can be contrasted with those of a recent study (Grimes et al., 2019) that examined the location choices of 'prime-workforce-aged' (25-54 year old) adults within New Zealand. That study found that New Zealand residents of this age-group are primarily attracted to places with high quality of life rather than by quality of business, while recent migrants to New Zealand are attracted to places with high quality of business rather than high quality of life. The locational choices of recent graduates contain elements of each of these two categories of migrant, although the observed shift of graduates towards productive places has a greater consistency with the behaviour of recent international migrants. Both international migrants and graduates are at the outset of their working careers within New Zealand, and so quality of business is likely to be more important for these groups than it is for established workers. A pattern of locating early in life in places with high wages, even if they have low consumption amenities, is consistent with lifetime utility maximisation for those with a low rate of time preference (Grimes et al., 2017).

While our estimated impacts are based on associative relationships, the results may be useful for local decision-makers when it comes to planning for the demographic and skills composition of their local settlement. For instance, decisions that favour the strengthening of productive relative to consumption amenities are more likely to result in a higher proportion of Commerce and Management graduates than would policy decisions that favour consumption amenities. Not only will local decisions regarding amenities affect the international migrant versus local resident composition of the population, but they will also influence the type of local graduate that is attracted.

Appendix

We use the approach of Gabriel and Rosenthal (2004) and Chen and Rosenthal (2008, based on Roback's (1982) spatial equilibrium model, to formulate our measures of quality of life (QL) and quality of business (QB) for each location. We assume that workers and firms choose to locate in one of C different (and separated) cities, indexed *c*=1,…,C. Firms use (mobile) labour and (immobile) land inputs to produce a tradeable good (Y). Workers provide a constant amount of labour, earning a locally determined wage (w_c), all of which they spend on a combination of housing (H_c) and consumption of Y. The price of housing (r_c) is determined locally while the traded good sells at the same price ($p_c = 1$) everywhere.

Cities have different endowments of (a vector of) productive & consumption amenities (A_c). Workers gain utility (U_{ic}) from their consumption of housing and consumption goods, and from local amenities in city *c*, where the utility function is given by:

$$U_{ic} = f_u(A_c) H_{ic}^{\alpha} Y_{ic}^{1-\alpha} \quad \text{(A1)}$$

Each worker locates in the city that maximizes their utility. A worker's expenditure is determined by city-specific wages so equals w_c. They allocate expenditure to housing and goods consumption according to first order conditions:

$$H_{ic} = \frac{\alpha}{r_c} w_{ic} \quad \text{(A2)}$$

$$Y_{ic} = \frac{(1-\alpha)}{p_c} w_{ic} \quad \text{(A3)}$$

These conditions yield indirect utility:

$$v_{ic} = \kappa_v f_u(A_c) \frac{w_{ic}}{r_c^{\alpha} p_C^{1-\alpha}} \quad \text{(A4)}$$

where $\kappa_v = \alpha^{\alpha}(1-\alpha)^{1-\alpha}$.

Firm *j* produces Y_{jc} using land H_{jc} and labour L_{jc}, at prices r_c and w_c respectively:

$$Y_{jc} = f_y(A_c) H_{jc}^{\gamma} L_{jc}^{1-\gamma} \quad \text{(A5)}$$

Profit maximisation under perfect competition yields first order conditions for housing and labour, and a marginal cost function:

$$H_{jc} = \gamma \frac{p_c Y_{jc}}{r_c} \quad \text{(A6)}$$

$$L_{jc} = (1-\gamma) \frac{p_c Y_{jc}}{w_c} \quad \text{(A7)}$$

$$p_c = \frac{r_c^{\gamma} w_C^{1-\gamma}}{\kappa_p f_y(A_c)} = 1 \quad \text{(A8)}$$

where $\kappa_p = \gamma^{\gamma}(1-\gamma)^{1-\gamma}$.

Spatial equilibrium requires that indirect utility and marginal costs are equalised across cities, implying (where $\bar{\bar{v}}$ is the reference level of utility across cities):

$$r_c^{\gamma} w_C^{1-\gamma} = \kappa_p f_y(A_c) \quad \text{(A9)}$$

and $$r_c^{-\alpha} w_c = \bar{\bar{v}} \,/\big(\kappa_v f_u(A_c)\big) \quad \text{(A10)}$$

In logarithmic terms, after normalising $\bar{\bar{v}} = 1$ and rearranging terms, (A9) and (A10) become:

$$(1-\gamma)\ln\left[\kappa_p f_y(A_c)\right] = \frac{\gamma}{1-\gamma}\ln(r_c) + \ln(w_c) \equiv QB_c \quad \text{(A11)}$$

and $$\ln[\kappa_v f_u(A_c)] = \alpha \ln(r_c) - \ln(w_c) \equiv QL_c \quad \text{(A12)}$$

Thus quality of business is derived as a function of rents plus wages in each city, while quality of life is defined as a function of rents minus wages.

In our empirical work, we use census data for each time period and each city to estimate the quality-adjusted rent premium in location *c* at time *t* [i.e. $\ln(r_{ct})$] where rents are quality adjusted for the number of rooms, number of bedrooms, dwelling type and available heating types in each dwelling. Census data is used also to estimate the quality-adjusted wage premium in location *c* at time *t* [i.e. $\ln(w_{ct})$] where wages are quality adjusted for age, gender, ethnicity, industry, birthplace, religion and qualifications. In each case, the chosen correlates reflect data available within the census. Based on aggregate data, we set γ, the coefficient on land (labour) in the representative firm's production function equal to 0.1; and set α, the coefficient on housing in the representative consumer's utility function, equal to 0.2. Thus:

$$QB_{ct} = 0.11\ln(r_{ct}) + \ln(w_{ct}) \quad \text{(A13)}$$

and $$QL_{ct} = 0.2\ln(r_{ct}) - \ln(w_{ct}) \quad \text{(A14)}$$

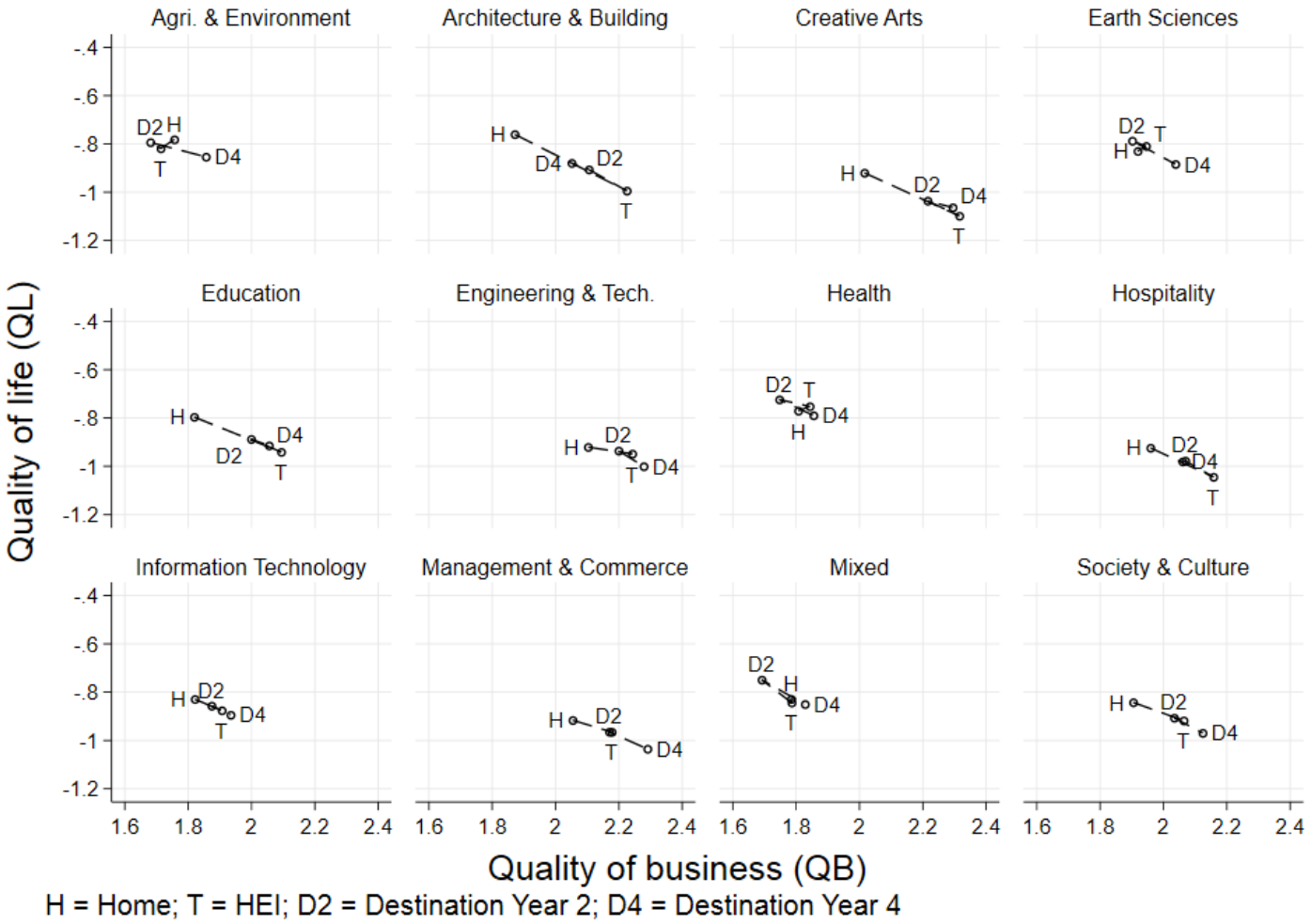
We calculate QB_{ct} and QL_{ct} for 130 urban areas in New Zealand, standardising their values to have mean zero and standard deviation one (across all 130 areas). For our analysis, we use the 31 urban areas that correspond to Statistics New Zealand's 'main and secondary urban areas' where, consistent with Preston at al. (2018), we aggregate several contiguous urban areas[25]. We utilise data for two census years, 2006 and 2013.

[25] Northern, Eastern, Southern, and Western Auckland are aggregated as Auckland. Wellington, Lower Hutt, Upper Hutt, and Porirua are aggregated as Wellington. Hamilton, Cambridge, and Te Awamutu are aggregated as Hamilton. Napier and Hastings forms Napier-Hastings. Brightwater is designated as part of Nelson.

Appendix Table 1. Urban Area Quality of Life and Quality of Business

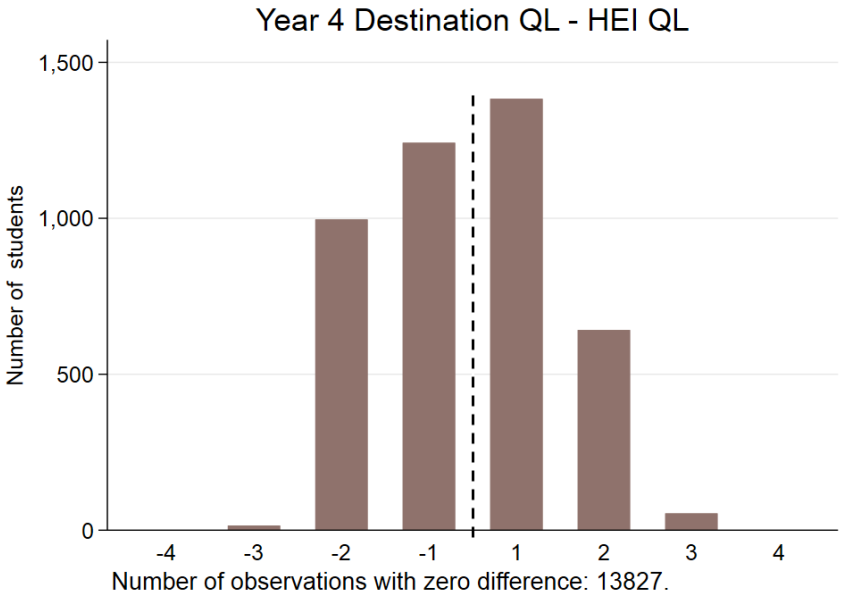
	Quality of Life		Quality of Business	
Urban Area	2006	2013	2006	2013
Ashburton	-0.563	-0.831	0.610	1.261
Auckland	-1.594	-1.117	3.324	2.691
Blenheim	0.423	0.483	0.333	0.087
Christchurch	-0.321	-0.368	1.344	1.402
Dunedin	0.196	0.111	0.552	0.466
Feilding	-0.404	-0.026	0.265	0.055
Gisborne	-0.588	0.112	0.281	-0.303
Greymouth	0.084	-0.401	-0.198	0.439
Hamilton	-0.901	-0.839	1.609	1.379
Hawera	-1.323	-1.469	0.640	0.900
Invercargill	-0.318	-0.512	0.202	0.314
Kapiti	0.600	0.484	0.446	0.539
Levin	-0.173	0.142	-0.300	-0.524
Masterton	-0.162	0.128	0.067	-0.015
Napier-Hastings	-0.058	0.221	0.513	0.167
Nelson	0.503	0.797	0.622	0.300
New Plymouth	-0.657	-0.695	0.868	1.139
Oamaru	0.244	-0.026	-0.810	-0.256
Palmerston North	-0.733	-0.513	0.895	0.630
Pukekohe	-0.747	-0.171	1.900	1.267
Queenstown	0.133	1.094	2.357	0.911
Rangiora	0.197	0.265	0.745	0.796
Rotorua	-0.730	-0.501	1.131	0.698
Taupo	-0.300	-0.146	1.152	0.783
Tauranga	0.037	0.112	1.089	0.831
Timaru	-0.475	-0.774	-0.005	0.379
Tokoroa	-2.147	-2.578	0.847	1.006
Wanganui	-0.512	-0.447	-0.295	-0.486
Wellington	-1.803	-1.385	2.832	2.517
Whakatane	-0.196	0.100	0.600	0.123
Whangarei	-0.852	-0.532	1.070	0.728

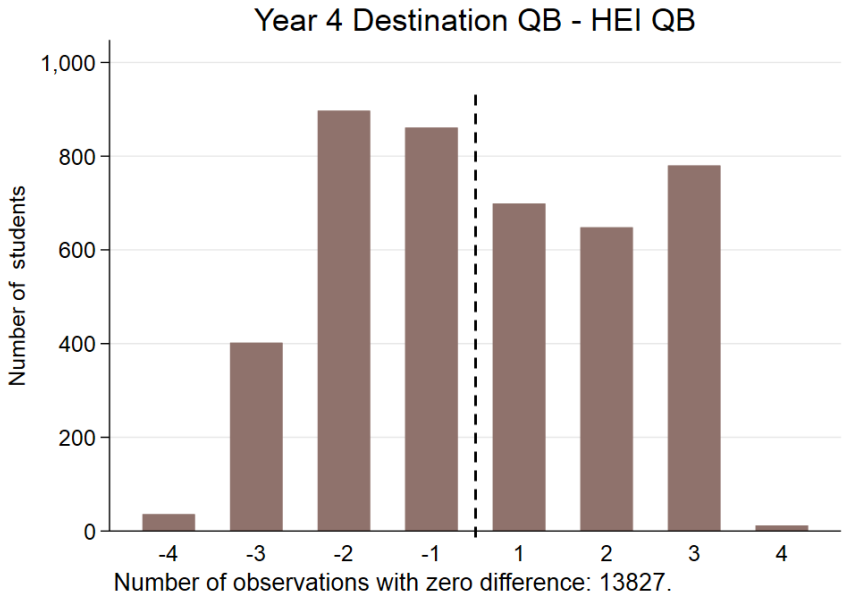
Quality of life and business measures are standardised to have a mean of zero and standard deviation of one, across 130 urban areas, and across each census for which data is available; 1976-2013.

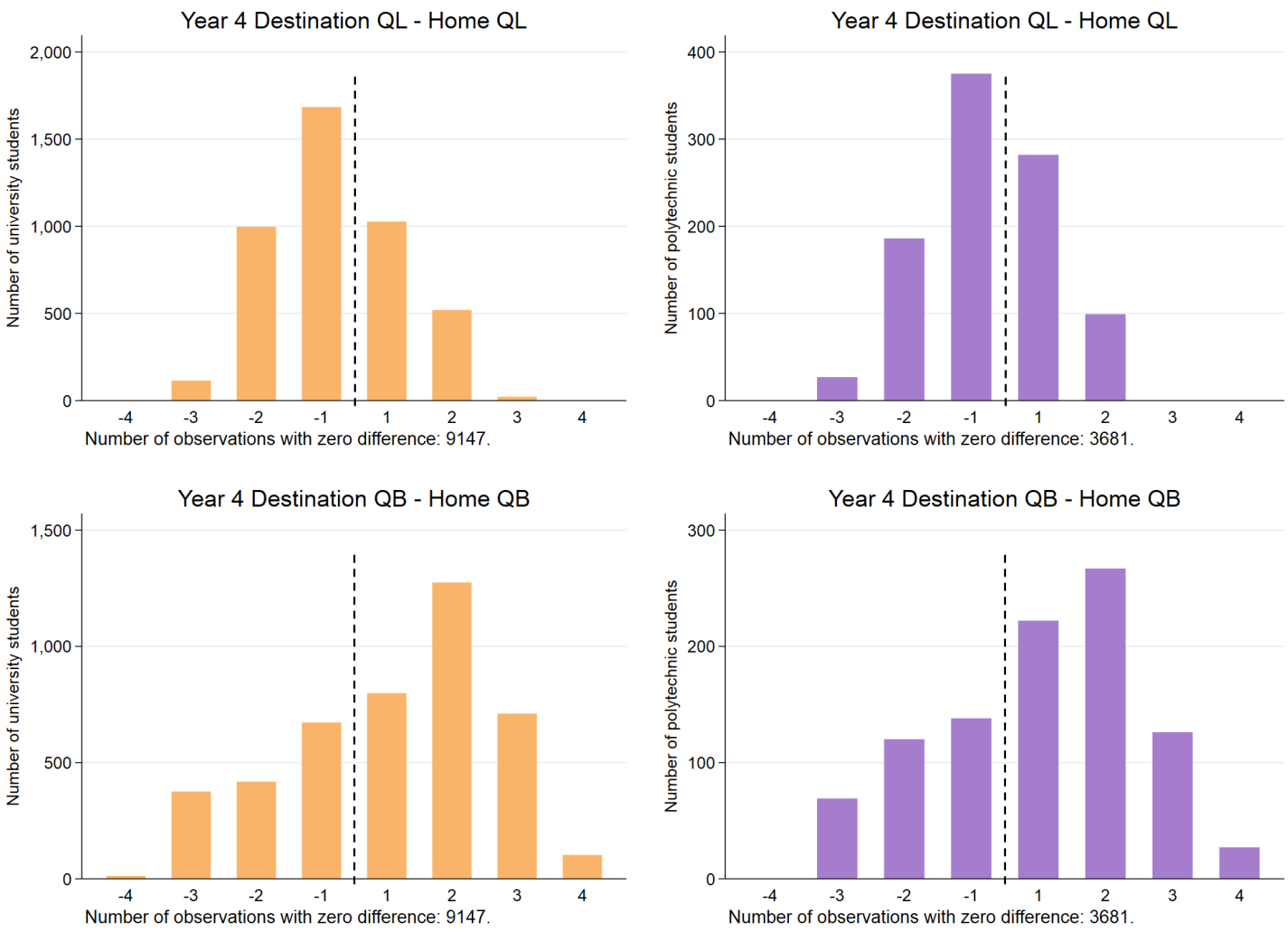


Appendix Figure 1. QL and QB by Home, HEI and destination locations, by field of study

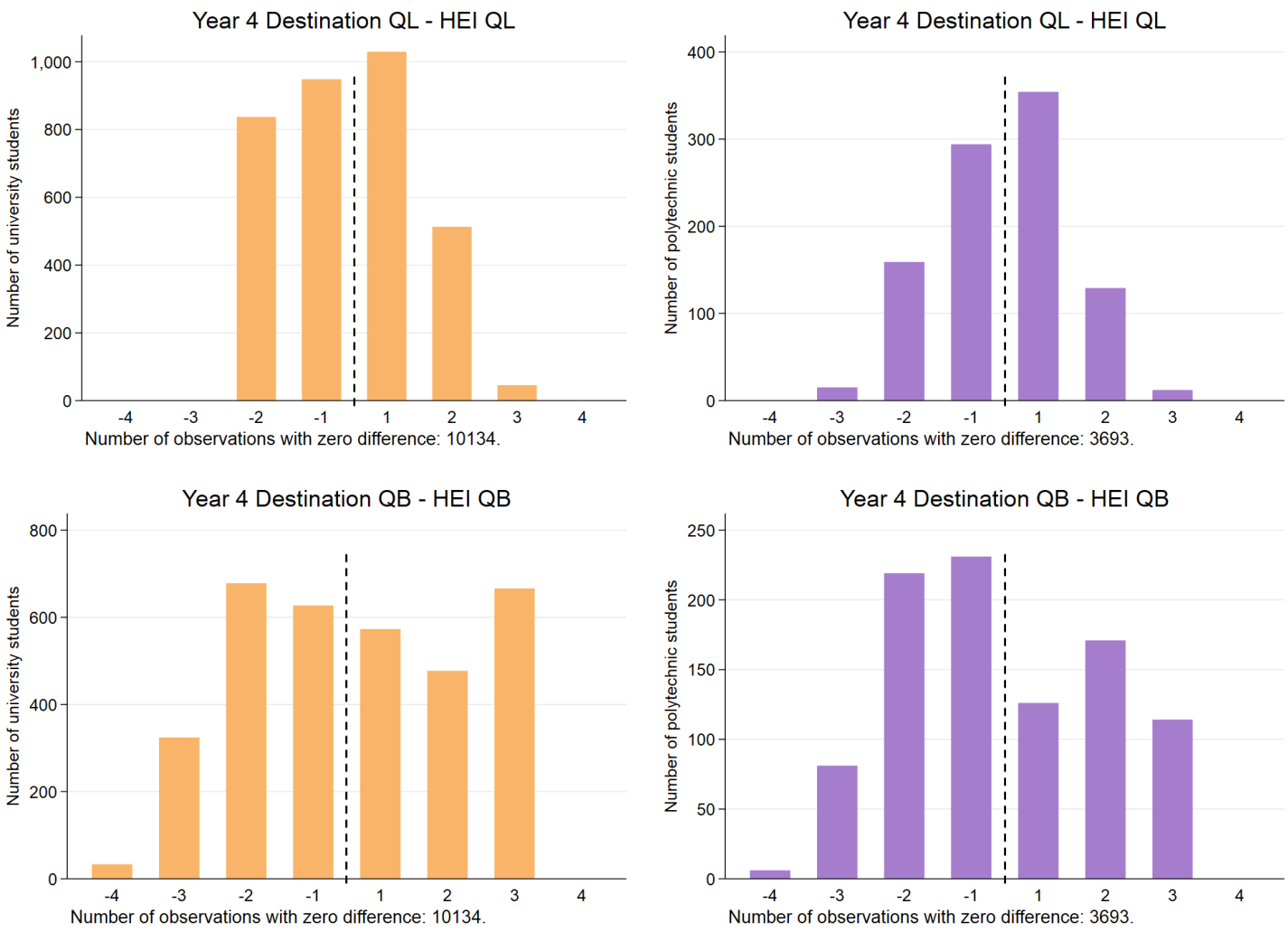
Appendix Figure 2. QL and QB Transitions from HEI to year 4 destination – All graduates







Appendix Figure 3. QL and QB Transitions from Home to year 4 destination – university and polytechnic graduates



Appendix Figure 4. QL and QB Transitions from HEI to year 4 destination – university and polytechnic graduates

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