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Implementing metropolitan planning strategies: taking into account local housing demand

TECHNICAL REPORT

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Implementing metropolitan planning strategies: taking into account local housing demand - TECHNICAL REPORT

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Introduction

This technical report documents the creation of a methodology which uses origin and destination of household moves to and around Sydney in order to better understand the functional drivers of the city's housing market. Using contemporary information on a household's origin and destination captures the essence of expressed demand and by profiling the flows of households by income and age we can better understand the nuances of this expression. It is a companion piece to the **Survey Report** (Pinnegar et al.,2013) report that details the rationale supporting a survey approach, the sampling strategies undertaken and the findings from the four developed surveys – recent purchasers, recent renter, long term owners and long term renters surveys. The survey report, essentially, brings to life the overall statistics presented in this report. It can be used to add character to these numbers, and so the two reports should not be seen as mutually exclusive. Understanding the push and pull factors behind housing and neighbourhood choice and how these operate differently across the city is as essential to the understanding of housing market operation as counting overall numbers.

The analysis detailed in the following report has been conducted using ABS Census information. Some of the information is readily available in standard tables, although the majority of the mobility data was structured using the Table Builder product. However, no additional special tabulations were requested from the ABS, thus meaning that the methodology set out can be easily updated when the 2016 Census becomes available. However, the methodology sets out a novel approach to turn flows of persons into flows of households. It may seem obvious to point out, but households are not people. Whilst the movement pattern of people provides insight into how the city is being used it sheds little light on how this use translates into housing demand. Conducting the analysis at the household level provides this utility, and provides a means by which to account for the influence of demand in supply.

This, we believe, is the first time (both in Australia and internationally) that a *systemic* reading of housing market performance has been developed which explicitly considers the movement patterns generated by households. It certainly *is* the first time that such a systemic household orientated analysis has been conducted at the local scale. Conducting such analysis at the local scale provides much greater utility for planning future housing demand as it enables place to be considered. Developing a better understanding of how places currently work, and how places are connected (or not) across the city offers the ability to think about how future supply could be articulated within these connections.

Attempting to present these relationships visually (where possible) also offers a means by which to broaden the accessibility of the research. Being able to present material that has been developed, at times, through quite complex processes in a clear and accessible manner can provide a means by which to utilise findings as the basis for more general discussions. In particular, visualisation of complex data can be seen as an essential strategy if such detailed analysis is going to be used for the purposes of community engagement, for example.

The mobility data presented in this report is, mainly, from the 2006-11 period. However, because the ARC Linkage commenced prior to the release of 2011 Census data the mobility information from 2001-2006 was utilised initially. It was deemed necessary to switch to the 2006-11 data during the project not just in order to gain a contemporary base for the analysis. The original Housing Market Demand Areas, termed HMDAs during the project (derived from mobility containment based on 2001-06 Census information) boundaries have, however, been retained. This has enabled the Linkage to further develop a knowledge base concerning drivers shaping these temporal shifts in demand boundary structure through the consideration of inter-censual housing demand change during the period 2006-11. To undertake this, profiles of housing demand have been developed for locations where the 2006-2011 derived HMDA boundaries deviate from the 2006-2011. Approaching the analysis this manner has allowed the research team the ability to consider how demand areas shift and mutate. Coupled to this, the findings have also enabled the team to consider approaches and recommendations that could be deployed to strategically leverage such fluctuations over time. Such approaches could be utilised during the development of future iterations of the overall "Tool Kit" approach being put forward by the Linkage. Using not just the Census profiling activity, but also the targeting of future surveys and, potentially, community and stakeholder engagement or other modes of research within areas experiencing spatial housing market rearticulation, would strengthen strategic planning engagement with housing supply through the consideration of local market fundamentals first.

The general findings of the analysis, however, will not come as a surprise to many readers. Households *tend* to move short distances, younger households *tend* to move more than older households and households *tend* to choose locations where households with similar characteristics already live. All these facts are intuitive, largely because they resound to the reader's experiences of moving home. What this report and the methodology detailed within seeks to demonstrate is the overall importance the specific context of the city can provide in realising how such general findings shape and drive the geographies of housing markets.

Report Structure

There are two parts to this technical report. The first deals explicitly with how a conceptual framework of housing market function was developed, and how it was translated into a methodological approach. By nature, this first section is *technical*, dealing within the datasets, programmes and packages used throughout the research. It is necessary to provide documentation of the methodological approach in this technical manner in order for others to replicate the processes if desired. The two main points of this section are:

- The conceptual framework – specifically the concept of housing career pathways and how these have been translated into patterns of household movement;

- How these patterns of household movement can be translated into broad geographical areas that capture the majority of movement (this section is titled “Moving into flows”).

The second part of this report provides an example of how statistical analysis can be conducted using the housing market boundaries and general patterns of movement. This is a substantive piece of analysis in its own right. It demonstrates how a demographically informed reading of housing market *function* can be developed. Many of the findings will be of interest to a broader urban policy and planning audience. More specifically, the findings seek to inform the metropolitan strategic planning processes tasked in planning Sydney’s future.

The general structure of the report is presented below. Note that certain sections of the report have been identified as “technical” and “non-technical” to help steer readers through the report.

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Conceptual and Theoretical Framework

The conceptual and theoretical framework developed for the analysis was, simply, tied to the production of two sets of housing market geographies for Sydney that would enable the Linkage to identify and discuss profiles of housing demand as they relate, spatially, to housing supply.

Housing is one of the unique market goods, people have to move to it in order to express demand. Consideration of demand *dynamism* as observable interactions derived from analysis of migration data has been demonstrated to have considerable utility for housing market research (Maher, 1995, Jones, 2002, Jones et al, 2004, Coombes and Champion, 2006, Hincks and Wong, 2010). Essentially, such approaches adapt and extend social area profiling by identifying groupings of areas that contain amalgamations of mobility based on shared origins and destinations. However, whilst such research provides a useful starting point for the consideration of demand dynamics, little has been done to aid the deliberation of such relationships within the milieu of supply. Furthermore, the ability to consider relationships within the context of how demand is currently utilising supply is lacking.

Planning for future growth along the lines of supply provision needs to understand how current and changing demand is utilising supply. Such considerations need to be able to understand current demand-supply interactions within the context of longer-term demographic exchanges. To this end, the ability to locate where these interactions are occurring becomes a necessity. Further to this, having a general theory about how demographic profiles operate within the housing market is of broad utility.

A connection can be made between the direct observation of household's mobility and theories concerning life-stage (Murie, 1974), careers (Beer et al. 2006) or pathways (Clapham, 2002) *through* the broader housing market. Since these relationships, as realised through local housing market supply, are constituent components of a location's profile, the general theoretical position presented is that this linking dynamic (life-stage, career or pathway) is embedded within the movement of households *between* areas of different housing supply. The interface between supply and demand becomes one in which the profile of supply and, *specifically*, differentiated areas of supply become enmeshed within the demographic linking dynamics of life-stages, careers and pathways.

Clark and Huang (2003) provide a conceptual position on this interface, specifically, that a housing market system consists of "… [A]*reas, or groups of areas, that contain enough options to enable choice to be made without sacrificing other Locational factors*" (ibid.). This observation provides the basis by which to relate patterns of household movement to those of underlying supply. The intersection of these two dimensions needs to be sufficiently reflective of current interactions whilst containing the ability for such choice to be exercised. Again, the ability to consider such interrelations, it is suggested, provides the ability to identify, work with and strengthen existing relationships where they currently operate. In doing so, the ability to strategically plan future housing supply may further be strengthened.

The two dynamics of supply and demand can now be reduced to a set of underlying rules for the purposes of conducting the following analysis:

1. Housing Market supply Areas (HMSAs) – captures the main profiles of **where** people are moving between, tempered with the ability to reflect the potential for local choice;
2. Housing Market demand Areas (HMDAs) – captures the main dynamics of **how** people are moving around, tempered by aspects of income and age.

Moving into flows

The following section is designed to guide the reader from a graphical representation of a known housing market function (the locality of moves) through to a spatial representation of this. In doing so the aim is to provide a means by which the reader can readily access and understand the majority of the map based materials presented in the remaining sections of this report. Essentially, this entails representing how the local nature of household moves plays out within the conditioned environment of Sydney.

Beginning with the 478,928 household moves made to and around Sydney from within Australia during the period 2006-2011, **Figure 1** presents these as a bar chart with distance of move as the horizontal and the moves presented as a percentage of the total (vertical axis). The upward trend in the earlier stages of the chart (up to 3 kilometres) accounts for 33% of total moves. After this there is a declining "tail" dropping off quite sharply, at the 9 kilometre mark just under 70% of moves is accounted for. At the 15 kilometre mark, 83% of all moves are accounted for. Of the final 17%, the vast majority occur before the 30 kilometre mark is reached.

In **Figure 2**, the colour scheme used runs from dark blue (moves of under 3 kilometres) through mid-blue (3-9 kilometres) and progressively getting lighter through the 15 kilometres, 30 kilometres and over 30 kilometres thresholds. The high level of activity seen in earlier in **Figure 1** is amplified, and also noted is the presence of highly localised structures operating in apparent semi-independence from each other. For example, there exists a nexus of mobility's operating in and around the higher density developments in Rockdale, an isolated conveyor running west to east in Sutherland Shire, an intermeshed conveyor running North West from central Parramatta and a highly contained set of moves circulating around central Fairfield. Other more local effects of significance are the apparent chain of moves occurring south to north along the North Shore train line and the isolation of south west Sydney from the remainder of the city.

Therefore, whilst the majority of moves occur locally they also generate unique patterns within Sydney. It is the presence of these locally generated patterns of data that the Linkage has used to generate the Housing Market demand Areas (HMDA). For a general readership just knowing that these structures of local moves exist is probably enough. The next section details how the analysis went about capturing boundaries based on these.

Figure 1: Distribution of household movement by distance

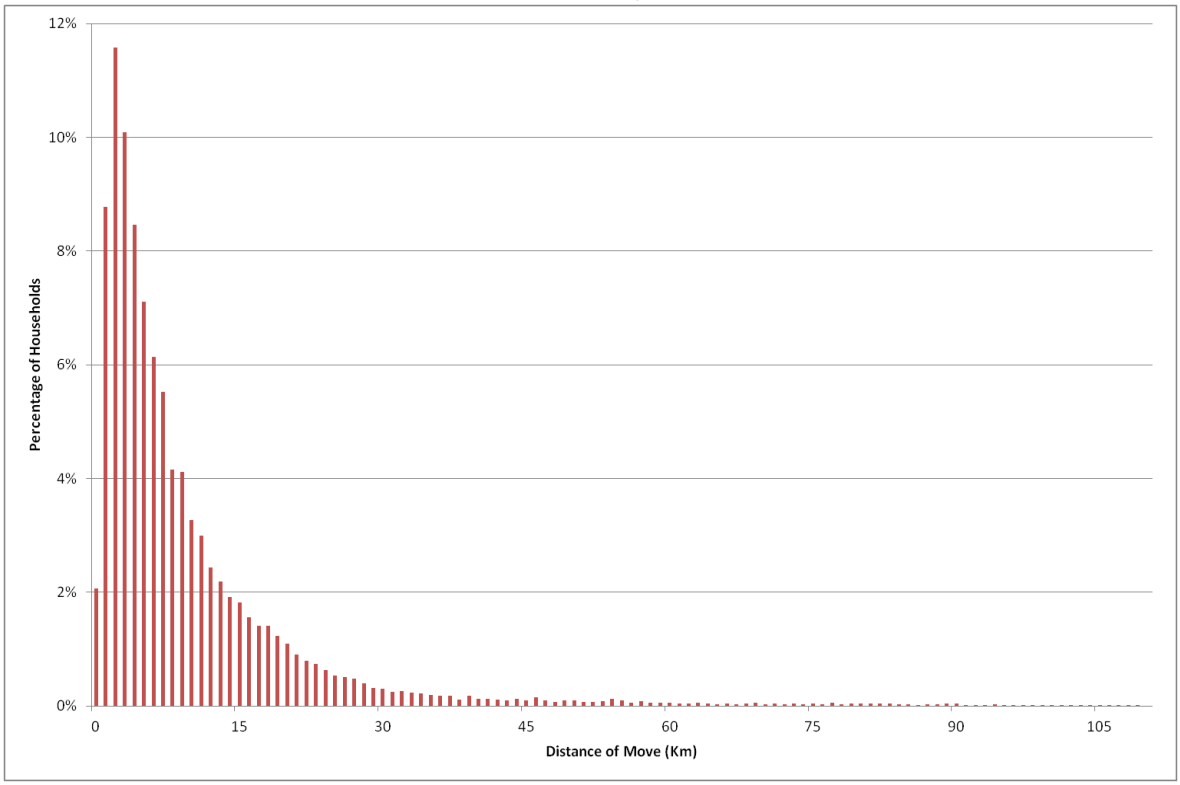
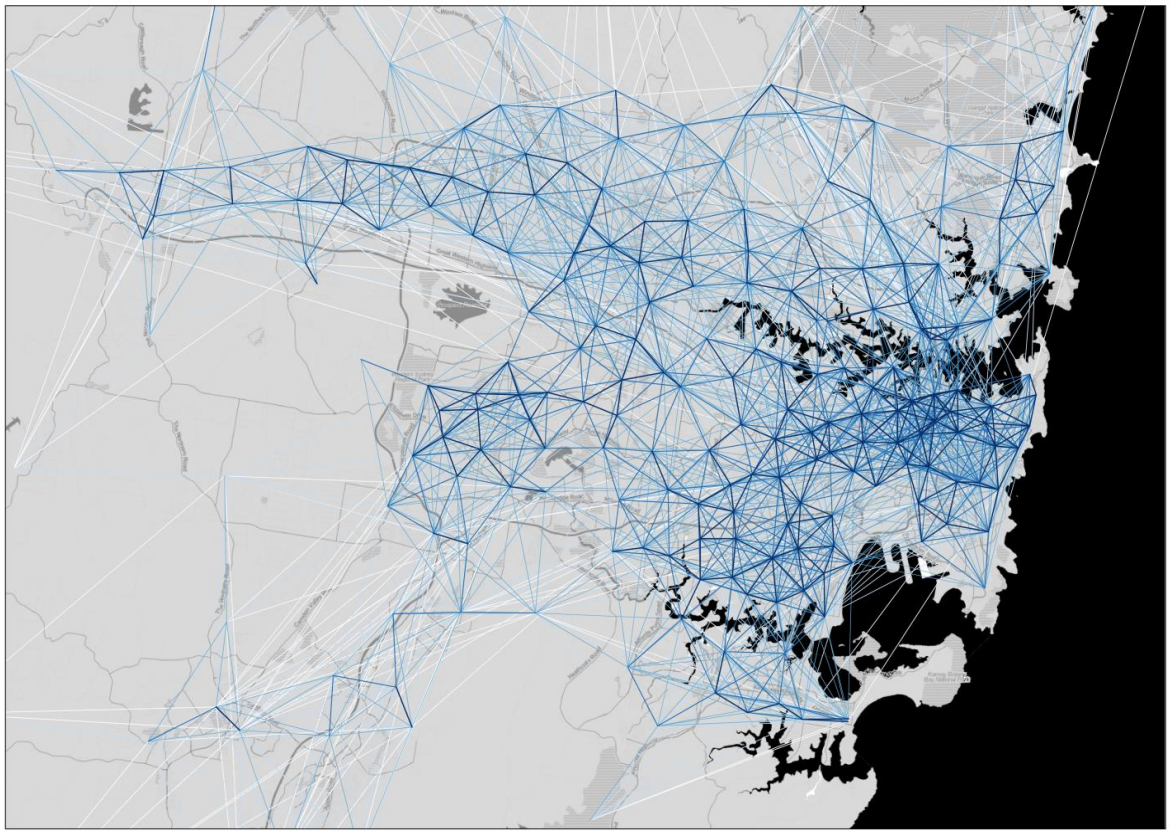


Figure 2: Patterns of household movement by distance



Data, packages and processing

The basis of the methodology is, simply, the development of a geographical framework that enables demand to be critically assessed against supply. This geography represents the *conditioning* context of the city by drawing on observations concerning the cross boundary function of housing market operation. As discussed previously the two sets of boundaries are couched in theories of life-stage market functionality. To this end, the following sets out the creation of demand (HMDA) and supply (HMSA) boundaries directly from Census based materials. Utilising a common data resource for the construction of both boundary sets minimises issues of discrepancies between sources and also provides a means by which to consider exact interoperability between expressed demand and supply profiles. Leveraging such interoperability entails nuanced manipulation of resources in order to maximise the scope of analytical options. The central method throughout this research and one which underpins much of the work detailed here entails the joining of origins and destinations and the attribution of these with information concerning the profile of persons and households moving between these locations. The technical process behind this is detailed in Appendix 2.

Data Elements

Throughout this research extensive use has been made of the ABS's Table Builder product. Table Builder offers the ability to manipulate (currently) both 2006 and 2011 Census data online. The main Table Builder database used was the Counting of Persons (Place of Usual Residence) for 2006 and 2011, which provided the ability to construct the movement datasets. These are the only databases which provide the Geographical Areas (Place of Usual Residence) variables and, most importantly, the Place of Usual Residence Five Years Ago (PUR5P). It is these two variables that are core to the analysis as (combined) they can provide origin and destination information. In the 2006 database the former SLA geography (of which there were typically two to three per Local Government Area) was used for the basis of analysis. There were 64 SLAs which comprised the Sydney Statistical Division, providing a pair-wise matrix of 4,096 (64^2) rows of origins and destinations. For the 2011 database the SLA unit is comparable in size to the new SA3 Unit in the Australian Statistical Geography Standard (ASGS), however, the Place of Usual Residence and Place of Usual Residence Five Years ago were made available at the smaller SA2 unit[1]. There are 279 SA2 units which now comprise the Sydney Greater Capital City Statistical Area (itself a replacement for the former Statistical Division). This means that a pair-wise matrix developed using the SA2 geography for Sydney now comprises 77,841 (279^2) rows of origins and destinations. As will be discussed later, the majority of this information is actually redundant for analysis as many of the linked origins and destinations don't contain actual flows of persons.

[1] A full description on the changes to the ABS's Statistical Reporting Geography can be found here: http://www.abs.gov.au/websitedbs/D3310114.nsf/home/Australian+Statistical+Geography+Standard+(ASGS)

On a technical aspect, it is evident that storage and manipulation of increasingly large datasets starts to become an issue as the geographical resolution is increased. This is especially the case when the need to bring in information on origins *outside* of the city is considered. Building a table comprising all SA2 origin and destinations for the entirety of Australia would generate a pair-wise matrix of some 4,901,796 (2,214^2) rows, far in excess of the number of rows (~90,000) that Table Builder will allow individual users to extract. Since the analysis was not concerned about the specific location of persons moving *to* Sydney from elsewhere in Australia a bespoke variable was created in the "My Custom Data" option. This grouped, for 2006, the 1,370 SLAs not in the Sydney Statistical Division and, for 2011 the 1,935 SA2's not in the Sydney Greater Capital City Statistical Area into a single variable – "Elsewhere in Australia". This custom variable is retained under the user's profile on Table Builder for future use.

The linked origin and destination tables can be easily collapsed to provide a count of persons (and households) that moved around Sydney. These values could, in turn, be compared to the number of persons who moved to Sydney from elsewhere in Australia. The final component of the movement analysis was to generate similar tables to count the numbers of persons or households arriving from overseas, this variable is already provided within the Counting of Persons Database under the UAI5P Usual Address Five Years Ago Indicator, which contains the "Overseas" category.

To generate the household count data used to develop the profiles of movers used in the analysis section of this report the Family/Household Reference Person Indicator (RPI) variable has been used. This can be found in the Counting of Persons (Place of Usual Residence) databases (for both Census years) in the Persons Classifications folder and the People and Relationships subfolder. The RPI contains four variables (Reference person in primary family, Reference person in second family, Reference person in third family and Reference person in non-family household) that can be grouped together in the Custom Data option to generate a household count that can be attributed to origin and destination information using the process describe previously. The ABS, however, describe the RPI variable as follows, with an important caveat about its terminology:

"The Family/Household Reference Person Indicator records the person who is used as the basis for determining the familial and non-familial relationships within a household. It is usually the person who has identified himself/herself as person one on the Household form. The household reference person in a multiple family household can be identified as the family reference person in the primary family.
This variable is to be used with caution as it is not an indication that a person is 'head of the household'". (2901.0 - Census Dictionary, 2011)

This caution has been noted within the research, however, for the purposes of the analysis the RPI can be reliably used to consideration of general patterns and profiles of household movement within Australia. Appendix 1 contains a discrete section discussing its validity and provides analysis to support the use made of this variable in the analysis. Two specific variables were used to cross break the origin-destination tables: the age of the RPI and the individual income of the RPI (Appendix 1 also provides validation of this). This enables the analysis to discuss general patterns of household movement by broad

age and income profiles. All other Census based resources have been extracted from the Table Builder product “as is” and are not subject to either origin or destination considerations, they will be introduced specifically later on in this report in the context that they were used. Before moving onto a general discussion on the software packages used for the analysis, the following sets out some general positives and negatives concerning the Table Builder product.

…a note of caution

It should be noted that the Table Builder product represents a serious step change in the manner in which researchers engage with Census derived analysis. Previously, outside of the standard provided Census products, the iterative strategy outlined above was limited in aspect. Special cross tabulations had to be commissioned from the ABS, the cost of these increasing in line with the number of cells within the table. Whilst costs have decreased substantially over time, large scale *spatial* interaction tabulations (for example those representing origin, destination and characteristics) remained prohibitively expensive. Coupled with this, commissioning such tables needed to be substantially justified prior to assessments by the ABS on the validity (or otherwise) of the information. Further, and as will be seen later on, one of the main issues of constructing interaction tabulations is that they contain many null values. Without the utility provided by the Table Builder the procurement of such detailed information would have entailed purchasing large amounts of cells which were essentially redundant to the analysis.

On purely economic grounds, there was therefore a serendipitous timing of the research to the development of the Table Builder product. However, the point made previously concerning the potential step change that this has engendered for Census based research should not be underestimated. The step change itself is double edged.

The positive is that researchers can slowly build up very complex information resources incrementally through a strategy that identifies sub components and testing the limits to what can be extracted from Table Builder. For example, the Household level Age-Income mobility table used later on in this report was developed from twelve separate downloads (one for each of the age groups from 15-19 year olds through to 70-74 year olds) with SA2 level origin and destination information cut by income banding. The combined table comprised some 10 million cells, although only 205,504 (~2%) actually contained values greater than 0. Therefore 98% of the data was redundant from the start. Being able to discover this without being financially penalised (heavily) is an amazing positive for the continuation of detailed spatial interaction analysis. It further empowers research teams with the ability to follow an iterative strategy of information development. Individual variables can initially be assessed (Age then Income independently, keeping with the example) for findings of interest and then subsequently combined only when necessary.

On the negative side, however, is the simple fact that whilst the previous commissioning of cross tabulations was expensive it did also mean that the ABS validated the veracity of the information. The onus to provide such checks and balances is now placed on the researcher. The identification and

assessment of the RPI methodology utilised in this research is a key example of this. This in turn places the cost of conducting such research on the individual not the information. Therefore the "free" information accessible through Table Builder attracts a cost based on both the length of time research teams might be *realistically* expected to follow iterative discovery and also linked to the processes of self-validation (see Appendix 1). On a final, more technical point, reporting on Census information derived in this manner means moving away from the referencing of tables (even as "Customised Cross tabulations") to the referencing of the specific data components used to generate the information. Doing so enables such information to be recreated by external researchers, either for the process of validation or future work.

Programmes

The information resources utilised for the creation of the HMDA and HMSA geographies are, as discussed previously, voluminous. Dealing with such large amounts of data in the "geography first" approach (which is central to the Linkage) entails getting to grips with the possibility that these datasets themselves contain discrete spatial patterns and clusters of data. As seen in Figure 2, patterns within the movement of households were visible; however turning these into bounded areas which share common characteristics is difficult. Therefore, whilst the eye can discern patterns, actually being able to assess these in terms of statistical reliability is central to the creation of the HMDA and HMSA boundaries

Fortunately, approaches to undertake just this form of analysis have had a long developmental history in the field of geographical exploration, especially with concern to urban analysis and the use of Census data (Berry, 1961, Johnson, 1970, Openshaw, 1996). Such activity is grouped under the banner of "regionalization" and, previously, has needed a certain degree of computer programming knowledge to conduct.

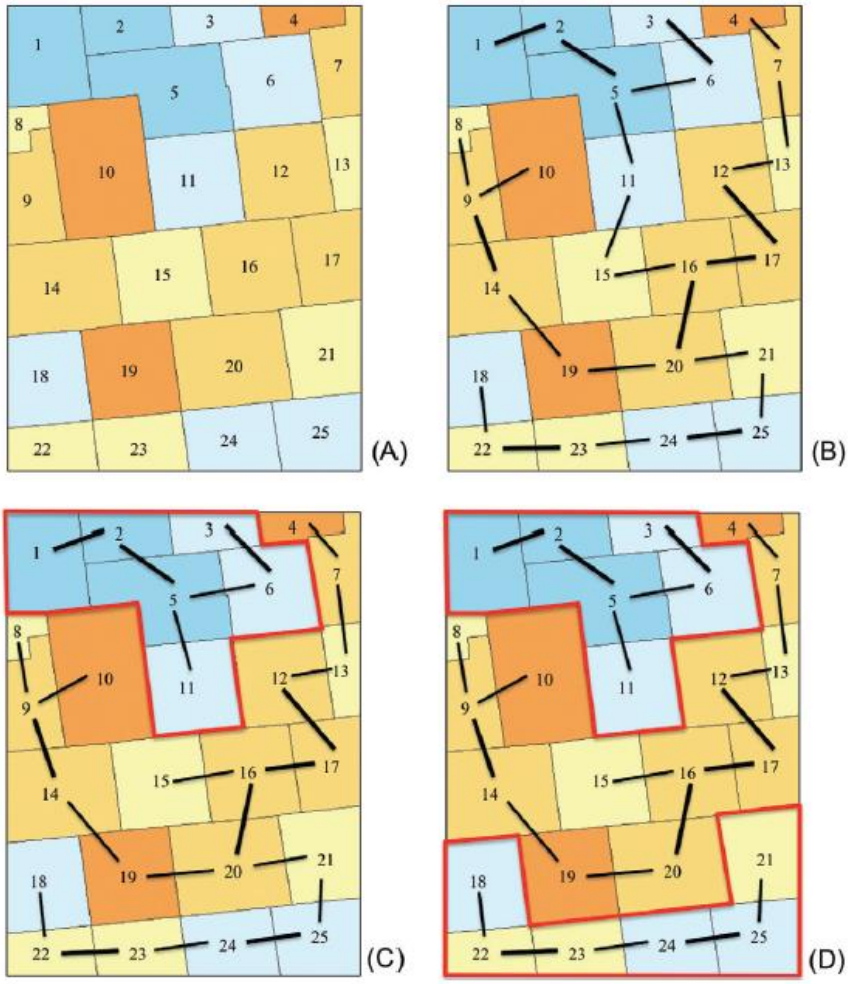
During the initial review of the current literature into the field of regionalization the Linkage identified a research team at the University of South Carolina (http://www.spatialdatamining.org/) who have been developing software to conduct such analysis. As well as providing leading edge methodological approaches to improve the accuracy of cluster detection, the research team have also developed the regionalization tools with relatively user friendly front end operation; meaning that much of the analysis can be conducted in a, relatively, straight forward manner.

The two packages used for the analysis are the REDCAP regionalization approach and the GraphREDCAP spatial portioning approach. Literature on the development of these and their operation can be accessed through the Spatial Data Mining Team's website, so for the purposes of this technical report only a brief overview is provided.

REDCAP

REDCAP builds regions from data using a SSD (sum of squared differences) approach. Essentially this means that all the separate values within a defined region must be different to other regions at a statistically significant level (this can be defined by the user). In order to generate the regions, REDCAP first looks for neighbouring units that share common *numerical* values (shown as the progression from (A) to (B) in **Figure 3**.

Figure 3: Overview of the REDCAP approach (source: Guo and Wang, 2011)



In the next step (B through C, in Figure 3) REDCAP considers whether spatial proximity of the units (neighbouring or touching) is more significant than the *numerical* values between the units. If this relationship is stronger the numerical relationship is discarded and the spatial relationship is enforced. This process is iterated (C through D) until a solution is reached that balances both numerical and spatial relationships and generates the final bounded (regionalized) groupings of these relationships.

GraphREDCAP

GraphREDCAP works on the simple premise of looking for concentrations of movement modularity – essentially the difference between actual and expected flows. It uses this value to identify groupings of regions which have similar levels of modularity. This value can be created from net flows of people (or households) operating between spatial units. Importantly it can be used to identify clustering of flows based around similar modularity thresholds.

Figure 4: Overview of GraphREDCAP process (adapted from Guo, 2009)

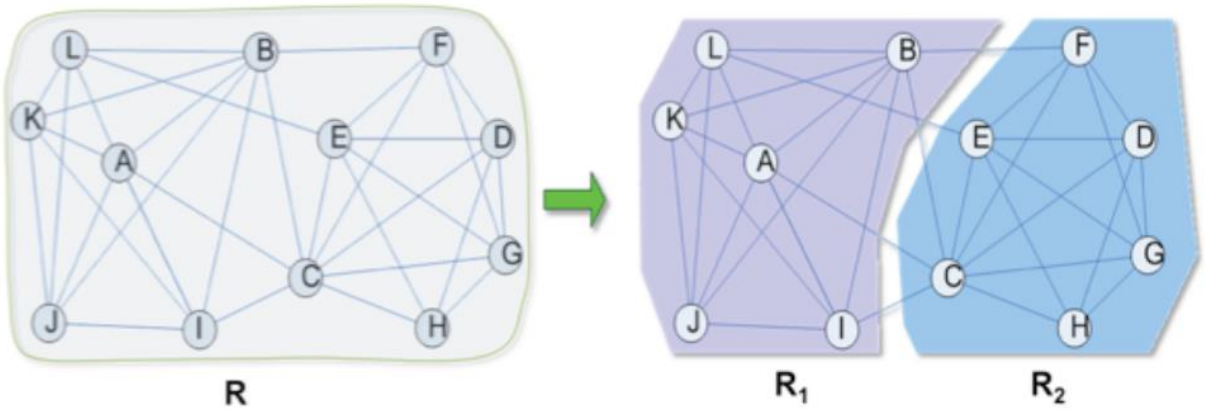


Figure 4 illustrates the approach. In the initial region there is a series of connections between different locations. Each of these connections may vary in overall volume (i.e. more persons moving along one connection then another), and may also vary in geographic distance. Both proximity and volume are considered in order to define spatial groupings. In Figure 4, whilst there are links between locations <I,C>, <E,L> and <B,F> the modularity of the flows is weaker than expected. It is this difference, rather than strict proximity that is used to define the basis of the regions identified in GraphREDCAP.

Building Housing Market Demand Areas

The chosen approach to identify locations of self-containment utilises the GraphREDCAP suite of tools (Guo, 2009) to build and spatially partition locations of similar flow-based interactions. Some of the processes are similar to REDCAP; however, the main difference is the level of considered linkages (numbers of persons, for example) moving between spatial units. For the purposes of the analysis the geographies used were the ABS's Statistical Local Areas (SLA) that, whilst relatively large in spatial extent (typically containing 30-60,000 persons), offer the greatest level of resolution available at which to consider these interactions.

Whilst GraphREDCAP enables population flows to be considered as absolute and net, it does not allow the assessment of control for variations in population size between areal units. This represents a potential limitation for the analysis given the stated variability in population sizes. A strong relational dynamic between two areas of smaller population sizes could be lost amongst those of a more sizeable nature. To work within this limitation, the intraregional migration data was pre-processed to calculate the flows as rates per 1000 persons.

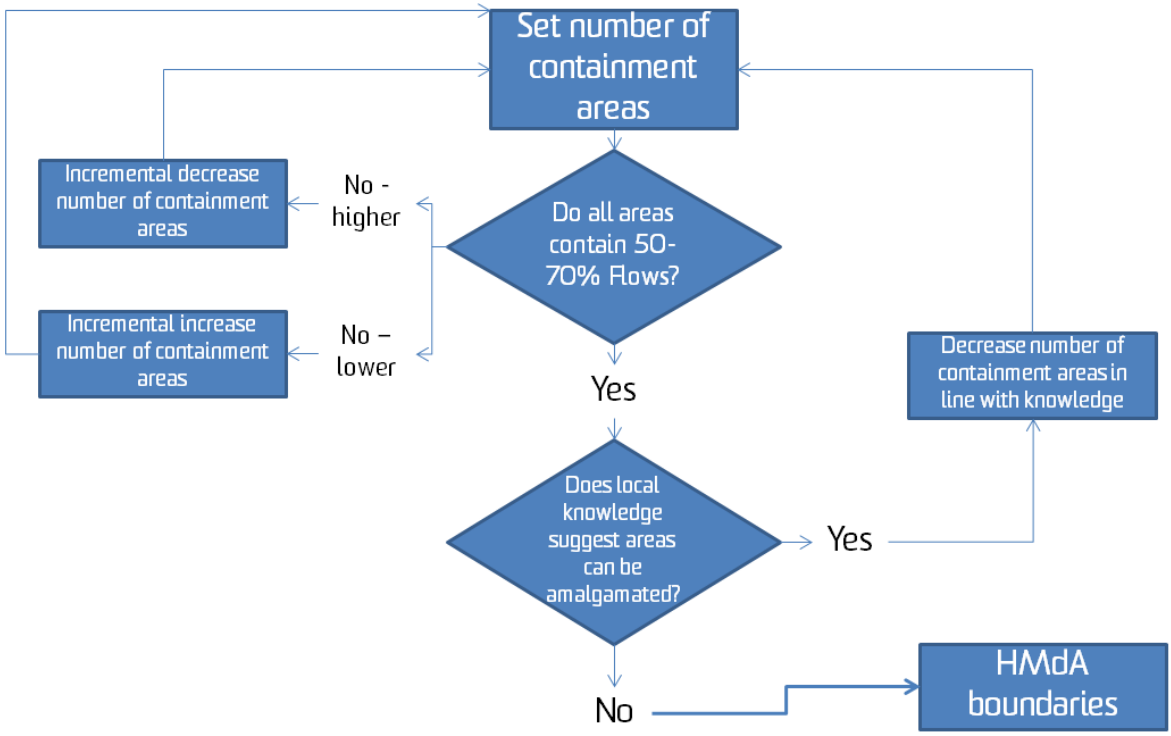
The chosen methodological approach for the creation of the HMDAs was the GraphREDCAP method developed by the team at the Spatial Data Mining and Visual Analytics Lab (University of South Carolina). GraphREDCAP, whilst dealing with spatial partitioning based on movement patterns, does so in a more explorative manner then previous spatial agglomerative based approaches; a facet used to benefit the overall Linkage, as will be explained below. In these older methodologies the researcher sets the threshold level of containment and then uses the method to identify geographies (amalgamations of sub-regions) that contain that threshold of origin-destination flows.

The threshold level utilised in agglomerative procedures is identified either through a prori assessment or based on existing literature. In the context of intra-regional containment, moves made within a larger region (for example, State or city), the generally agreed thresholds are between 50-70%. The evidence base for this range is drawn from extensive analysis based in the field of labour market analysis, specifically the creation of "natural" labour market areas for reporting on labour market data (unemployment for example). Creating these "natural" labour market areas, it is argued, better represents the interactions between labour market statistics and the state of the local economy. The creation of these areas, therefore, offers policy makers the ability to consider specifically tailored approaches for local policy development. These are developed through analysis of individual Journeys to Work. The upper threshold (70% containment) is set to exclude from the boundary creation longer distance commutes as these could serve to extend the area of containment towards the regional level (i.e. too large). The lower threshold (50% containment) representing the minimum before individual sub-regions become isolated entities in their own right. Since the containment process is seeking to discover groupings of sub-regions, the lower level threshold exists to ensure that such groupings can be identified.

Where GraphREDCAP differs, is that thresholds aren't set in the initial stages. Instead the methodology identifies set groupings of sub-regions put in place by the researcher. The level of containment achieved within these set number of groupings can then be assessed, and alterations purposed. To an extent, this can be seen as a more intuitive process. Whilst the methodology is "deciding" on the agglomerative geography (which regions can be grouped, based on the strength or absence of flows) the research team retains the ability to nuance these with local level understanding. In the example of the creation of the HMDAs, the initial run of GraphREDCAP was set at the identification of nine regions within the city.

The general reasoning behind this threshold was, simply, that nine regions should offer a reasonable level of spatial resolution by which to divide the city up into functional demand areas whilst retaining the ability for straight forward comparisons to be made. Coupled with this, and with an eye to the survey component of the Linkage, it was anticipated that the creation of too many small scale regions would have a detrimental effect on achieving robust sample sizes. To this end the decision to start with nine groupings was itself a pragmatic response to the manner in which the final groupings were to be used to analyse the city.

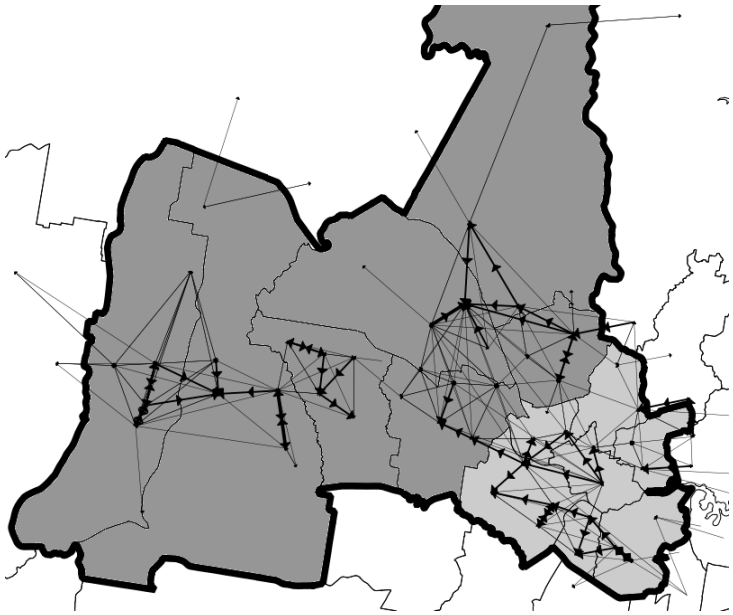
Figure 5: Indicative flow process used to generate Housing Market demand Areas



Setting the initial threshold at nine regions identified seven out of the final eight which were used for the rest of the analysis. The two extra regions identified fell within the final Parramatta and North West HMDA (**Figure 6**). On assessment of the containment levels within the nine region solution the seven extant

regions had containment levels of between 60-70% and the two within Parramatta had containment levels closer to 50%. A review of the actual pattern of intra-regional flows within and between these two locations indicated a high level of churn within Inner Parramatta (light grey) but with evidence of flows connecting this to a broader structure operating between Blacktown and the Baulkham Hills. Under discussion with the partner agencies, this relationship was identified as a relatively known housing market process (persons initially locating in Parramatta and subsequently moving to surrounding lower density locations). To ascertain whether this relationship held within the data the threshold for area identification in GraphREDCAP was set to eight, and the process rerun. As before the 7 extant regions were identified and the Parramatta and North West region became amalgamated. Rerunning the containment levels identified that this new region approached the upper 70% threshold level.

Figure 6: Broader Parramatta and North West HMDA (thick black line), initial HMDAs (light and dark grey) and main flows – note minimal presence of flows into and out of the final HMDA.



Essentially, the GraphREDCAP process identified the underlying differences in movement patterns between the “core” (higher density and associated higher churn) section containing central Parramatta and the “fringe” patterns within the broader North West region. Whilst the nine region solution initially presented captures these differences, the application of local knowledge (the connectivity of the higher churn core to the lower churn fringe), when applied, served to define a more logical regional grouping for the purposes of both the research and the linkage partners. Being able to balance out the strictly applied (and technical) “numbers game” solution (the nine regions) with local embedded knowledge, whilst retaining a “geography first” approach, demonstrates the relative merit in the selection of the GraphREDCAP approach.

Figure 7: Housing Market Demand Areas

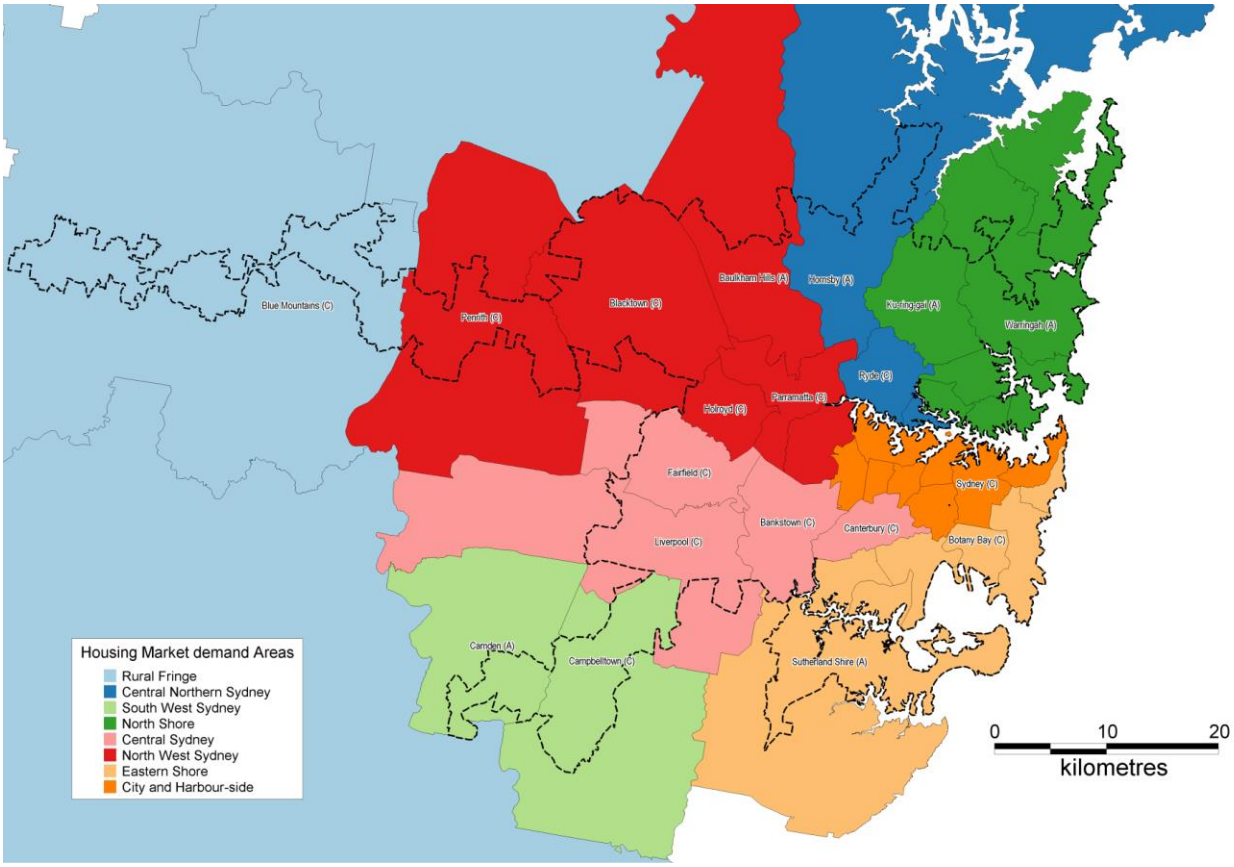


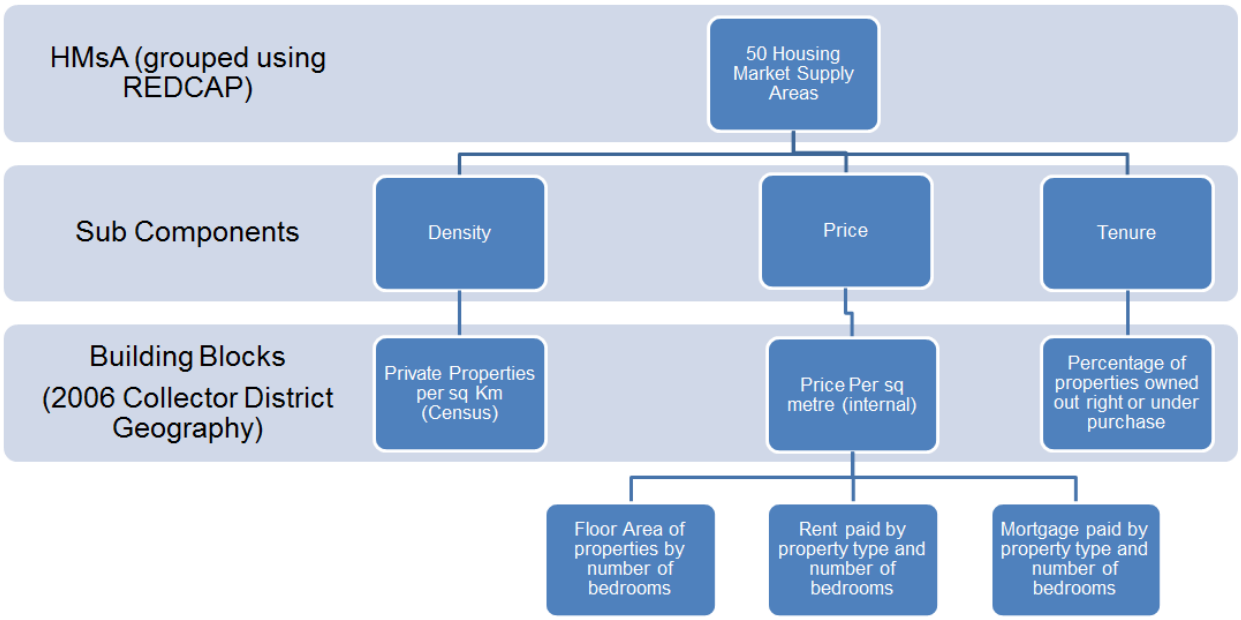
Figure 7 sets out the HMDA boundaries as generated for 2001-06. The Rural Fringe HMDA (extreme left of the figure) extends around the metropolitan area running from Gosford in the north (not shown on figure), through the Blue Mountains. The Eastern Sydney HMDA is split in two by the Georges River and includes Sutherland Shire. Parramatta and North West also includes Auburn and the boundary between it and the City and Harbour Side HMDA is around Rookwood Cemetery. The majority of the South West Sydney HMDA is comprised of semi-rural lands and potential Greenfield sites, as is the large area in the west of the Western Sydney HMDA and the north west of the Parramatta and North West HMDA. Central Northern Sydney and the North Sydney (and Shore) HMDAs similarly contain large areas of non-residential lands, mainly comprising a national park. Finally, the southern extent of Eastern Sydney (south of Sutherland Shire) is also national park.

Building Housing Market Supply Areas

With the broad areas of functional housing market interaction demarcated this section turns to a method to consider the form of the locations within which the households move. The rationale for this methodology is the creation of a geography of supply typologies built from key pieces of information. These pertain to both built form and whether the properties are rented or owned. These key pieces of information (identified below) were amalgamated into group regions (the HMSAs) which share relatively common profiles overall. The package selected to facilitate this grouping process was REDCAP (described previously).

Figure 8 presents the general flow of the methodology undertaken. Starting at the bottom, individual variables were grouped together to generate a constant coverage across NSW (at the 2006 Collector District geography) of the three elements defining housing supply (density, price and tenure). These were then passed through an iterative process using REDCAP in order to group these into the Housing Market supply Area amalgamations.

Figure 8: HMSA methodology



At the lowest level outlined in **Figure 8**, is the identification of the sub-components of supply market geographies. The general process that was undertaken was based around a consideration of whether a local supply area is comprised of one dominant property form or a collection of properties that, whilst sharing similar characteristics, could facilitate housing pathways or careers to be sustained without sacrificing other beneficial spatial relationships. Variables that represent common facets shared by all

residential properties would appear to be a logical choice. Proximity to other residential properties is one such facet and price paid (either through mortgage or rental costs) is another. The first facet is commonly constructed as numbers of properties per square kilometre (Kulish et al., 2011) and can be used as a short hand for overall property form. Cost, constructed as price per square metre, has been demonstrated to be representative of wider urban process (Spivey, 2008). Including such a variable in a reasonably simplistic manner also renders properties with different attributes (i.e. numbers of bedrooms), but sharing the same relative location characteristics, comparable. Whilst the preceding two variables represent form, there is a need to relate these to utilisation. The Australian housing market is largely split between homeownership and private rental (social housing only accounts for 4.5% of total supply (ABS, 2006)), with an evidenced housing career (Kendig,1984) from owner occupation (the parental home) to private rental (after initially leaving the parental home) and back into owner occupation. Whilst this trajectory has altered somewhat in the proceeding 20 years (Beer, 2005) the distribution and availability of these two different tenure forms remain to shape and define underlying patterns of demand. It, therefore, becomes a necessity to include such a variable to derive the HMSA geography.

Table 1 translates these considerations into the variables used for the analysis. Again extensive use of the Table Builder product was made to extract the majority of the property variables. Two additional resources were used: the first is the ABS's Mesh block geography[2]. The Mesh block geography was utilised to generate a more accurate assessment on the nature of residential density. It provides a specific classification of Residential lands at a very detailed level (typically groupings of 30-50 properties). These values can be summed to the SA1 (or in the case of the analysis the 2006 Collector District) level in order to negate the influence of non-residential lands reducing the overall assessment of residential density.

The second resource was primary developed and entailed a review of property sales on the Domain website. This was undertaken to derive a schedule of internal floor spaces of properties by both built form and numbers of bedrooms (**Table 2**). This information was used to develop a method to construct a schedule of price of property by sq. metre. This schedule was then constructed as a weighted average by property form and attributed to the mortgage and rental values reported by property form. To control for issues of skew deriving from the presence of very large properties, only values derived from properties with 4 or fewer bedrooms were used.

[2] http://www.abs.gov.au/ausstats/abs@.nsf/mf/1209.0.55.002/

Table 1: Broad variables used for Regionalisation analysis

Variable	Composite Parts / Analysis	Caveats
Density	2006 Census data at the Collector District level. First, using the Mesh block geography, select all classified as residential. Used to calculate residential properties per sq. km.	N/A
Price	Two Step approach: Rent and Mortgage schedules derived at the CD level by property type and numbers of bedrooms. Indicative area of property calculated from the schedule. Rent and Mortgage values divided by derived property area. Values used to create weighted average price per sq. metre. This was used for the base of the analysis.	Does not capture potential for low (or nil) mortgage payments amongst long term home owners. Those households who have paid down their loan over time could have low housing costs in a *defacto* expensive location.
Tenure	2006 Census data at the Collector District level. This is structured as percentage of stock in owner occupation (including being purchased), decreasing percentages of owner occupation therefore capturing by default an increasing number of rental properties. Percentage then normalised using Z score.	Social Renting (either state or third sector provided) is treated the same as Private Rental. Concentrations of Social Renting may be initially misidentified as Private – subsequent analysis needed to identify submarkets where this may be the case.

Table 2: Average internal area of units and houses – derived from review of sales adverts on Domain (http://www.domain.com.au/)

Bedrooms	Units	Houses
1	37-68	50-70
2	69-88	75-95
3	95-109	95-140
4	110-135	140-200

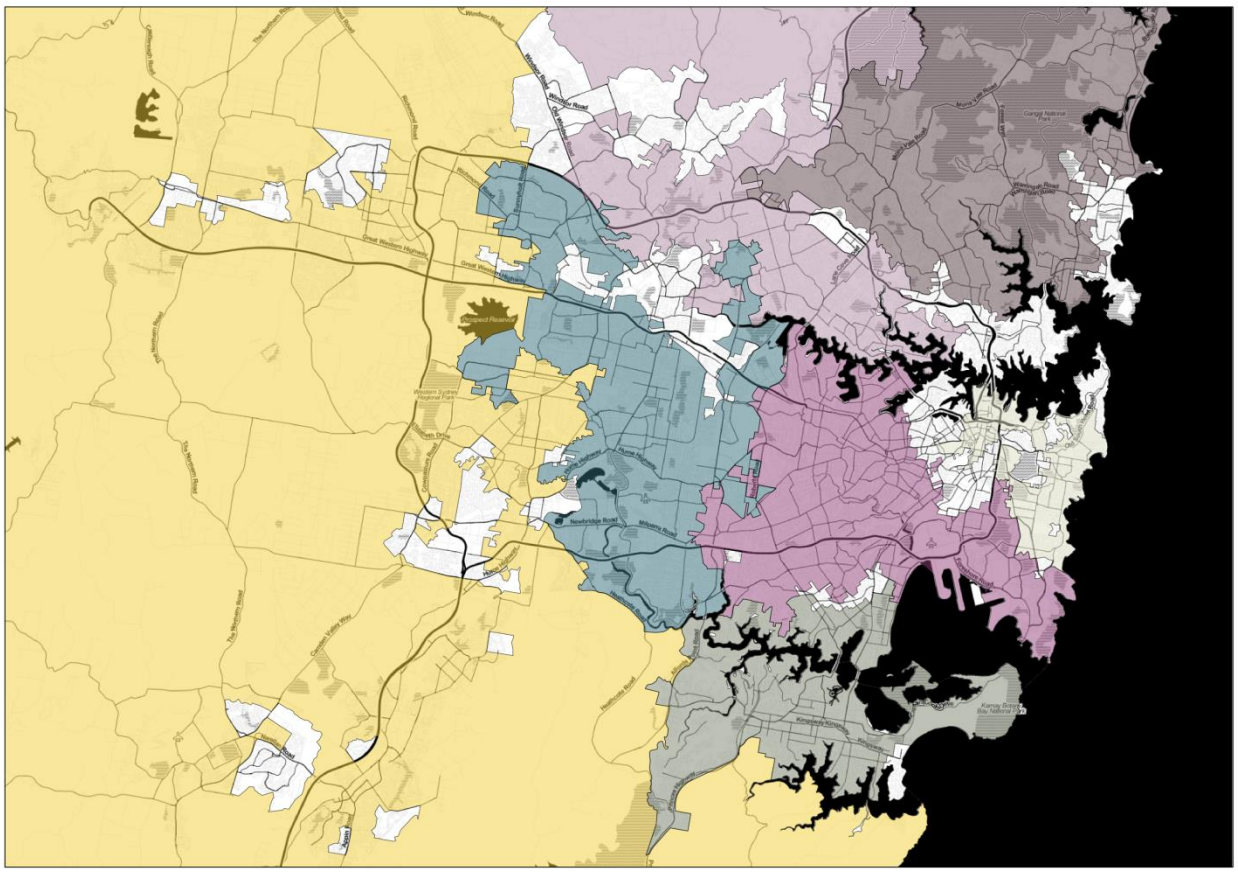
The three composite variables were used as a basis for the REDCAP region-building algorithm (Guo, 2008). Essentially this process looks for groupings of locations that share a common combined profile and demarcates these groups. Under review of the literature on REDCAP (Guo and Wang, 2011) the settings used were the Complete-Linkage (CLK) with a local empirical Bayes Smoother (EBS). The CLK methodology as a stand-alone approach has been demonstrated to be the most successful under true positive tests and the addition of the EBS enables issues of low population numbers to be handled.

As with many data reduction exercises, the user subjectively sets the exact number of discrete profiles and some justification is necessary. In the geography presented the number of iterations was set at 50 (i.e. after the identification of the 50 distinct profile the algorithm ended), although this number was arrived at through an iterative deductive process. The base geography for the clustering process was the ABS Collector District (CD), some 1,166 discrete areal units. An initial “top-end” threshold was set at 20% of

these (i.e. the regionalisation algorithm was set to end on the identification of the 233rd discrete spatial entity). Keeping in mind the utilisation of the HMSAs this “top-end” threshold could lead to too many spatially defined cut points by which to meaningfully analyse survey returns. However, even at this “top-end” threshold seven broad sub-regions were identifiable (**Figure 9**), indicating that based on the data provided the regionalisation process was unable to discern other areas of broad commonality within these larger regions. Where localised variation *did* occur subsequent analysis indicated that a large majority of these contained high levels of non-private dwellings (extra-care homes, prisons, hospitals and similar) or very small numbers of geographically isolated properties

To ascertain when these seven broad HMSAs coalesced during the process the threshold was then set at 1% of the 1,166 CDs (16 regions), 2% (23 regions), 5% (58 regions) and 10% (116 regions) levels. At the 1% level, the process only identified a few other major urban locations across the State with two HMSAs within the Sydney Metropolitan area. At the 2% threshold, two of the seven subregions remained combined, and between the 5% and 10% thresholds, the identification of highly localised phenomena described previously began to dominate the process. For presentation purposes, the final threshold was set at 50 (eight regions less than derived at the 5% threshold). The eight regions removed by this decision, on subsequent analysis, represented high concentrations of social housing supply. Social Rental, as flagged in the caveat to the tenure variable, should not be conflated with Private Rental due to the extra-market nature of this supply. To this end, the justification of the removal of eight sub-regions (to arrive at the 50 presented) reflects insight into the concentrated nature of this form of supply.

Figure 9: Broad areas of common supply profiles



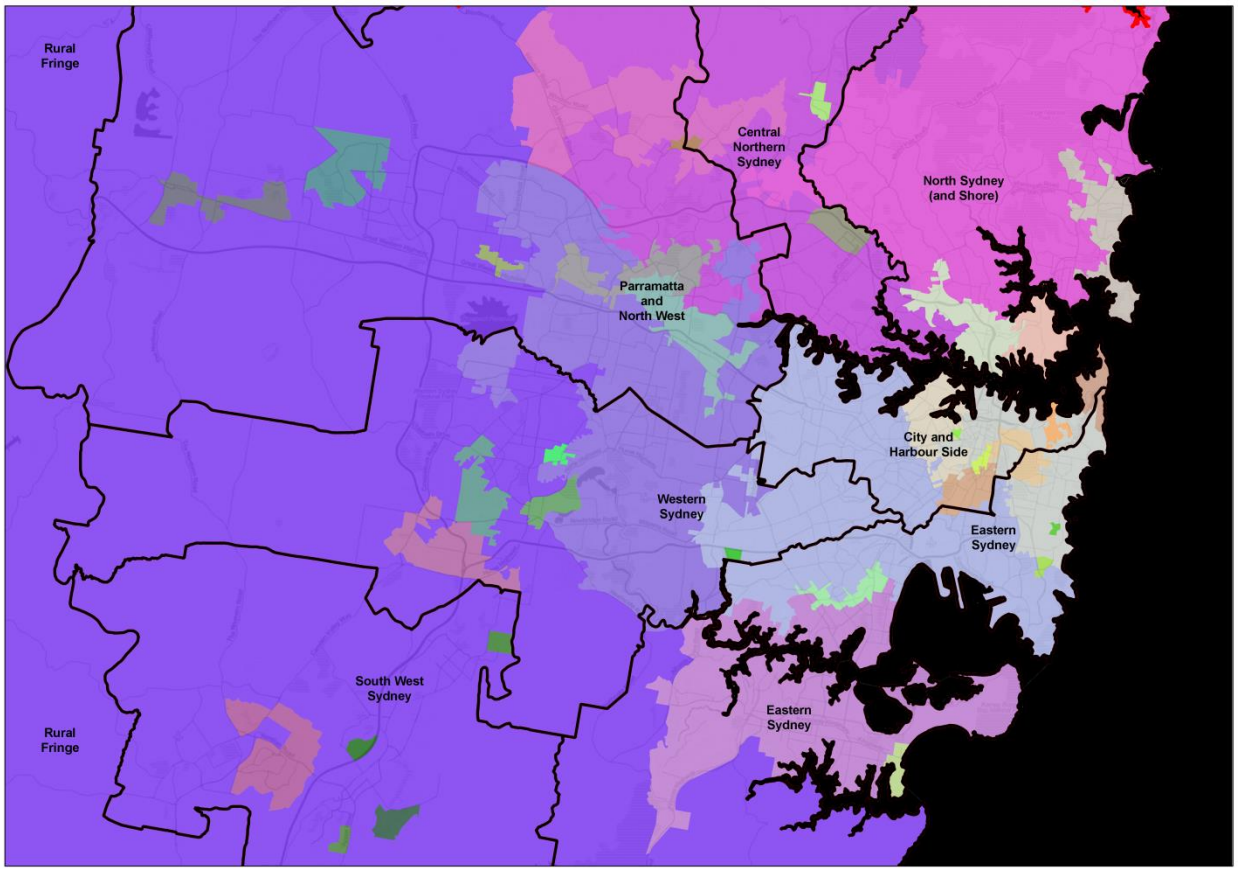
Whilst the profile of the 50 functional supply regions could be produced in a tabulated manner, detailing the specific mixing of the underlying variables, such an approach would move the analysis away from its desired aim to be able to communicate as much as possible in a visual manner. To this end, **Figure 10** uses a Red-Green-Blue (RGB) composite approach in order to give an overview of each area's underlying supply profile. A broad array of constitute colours can be defined by the amount that these primary colours contribute, and whilst the RGB model is widely used to display colours electronically, there is also solid theory predating these applications (Hunt, 2004). The contribution of each primary colour, for electronic representation, is based on a scale of zero (absolute absence) through 255 (absolute presence) where a combination of 0,0,0 represents black and 255,255,255 represents white. To achieve the colours represented, the Z-scores for each composite variable (Price, Density, and Tenure) were converted into a scale running 0 to 255 (absence to dominance, or low to high) and assigned to each primary colour: Price to Red, Density to Green and Tenure (ownership) to Blue.

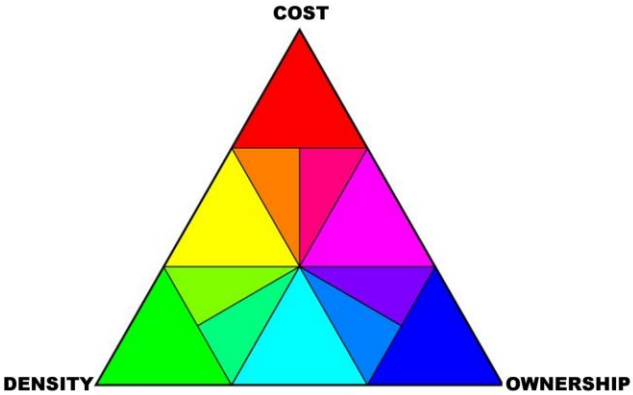
The legend included with **Figure 10** sets out an example of how each combine and relates this to five of the actual colour composites achieved. The varying shades of purple represented in the overall map

capture the dominant profile of the city's housing supply, a mixture of lower-density properties of varying cost and tenure combinations. However, within this, locations with distinctly different profiles can be observed. By overarching Housing Market demand Area some of these are:

Rural Fringe	Broad distribution of lower density, lower cost properties throughout the area.
South West Sydney	Broad distribution of lower density, lower cost properties. Key concentration of higher cost, lower density location (new release) and pockets of higher density social housing (green).
Western Sydney	Transitioning from a higher cost mix of types and tenures in the east through to lower cost and lower density in the west. Pockets of higher density rental locations (Central Liverpool and Fairfield) and higher cost, lower density (new release).
Eastern Sydney	Ranging from a mix of high cost, higher density, mixed tenure in the north, through higher cost mix of types and tenures and into high cost lower density in the south. Key pockets of higher density rental dispersed throughout.
City and Harbour Side	Mainly mixed density higher cost locations.
Parramatta North West	Lower density, mix tenure in the south. Ranging through key areas of higher density. In the north the presence of established (expensive) lower density and also fringe release locations.
Central Northern Sydney	Broad area of high cost, low density. Concentrations of higher density in Macquarie Park and around Hornsby.
North Sydney (and Shore)	Two discrete areas of mixed tenure and density abutting broad areas of high cost and low density.

Figure 10: Composite Housing Market Supply Areas





- Lower Density | Medium Cost | Higher Ownership
- Higher Density | Higher Cost | Higher Rental
- Low Density | Low Cost | Higher Rental
- Low Density | High Cost | Higher Ownership
- High Density | Low Cost | Higher Rental

Spatial Accounting: Profiling Sydney's Housing Market Function

The following develops a profile of housing market dynamics through a process of spatial accounting. There are four discrete sections, with each setting up the rational for the analysis conducted in the next. The sections are:

Mover profile by age-income – this section looks at the broad profile of households who have moved around Sydney;

Net Change in Occupied Residential Properties – Chains of Movement – this section considers overall housing market outcomes generated by the moving households, essentially what stock has been utilised where to facilitate this movement;

Intersection of Chain Movement within Supply – this section, briefly, considers main movement patterns between different areas of supply;

Influence of Immigration – this section considers the impact immigration (of all forms) might be having on driving housing market function in Sydney.

A conclusion section summarises the four sections and looks back at changes in the overall population structure of Sydney. This is used to frame many of the findings discussed in the previous sections.

Throughout the base denominator is the number of occupied private dwellings. Utilising the count of occupied dwellings is useful as it enables the analysis to make a further distinction between overall property numbers and how realised demand is being expressed. The profiles are for households in the private sector – social housing is excluded. Private Rental is treated as an integral part of housing market function and therefore its specific role in this is not directly commented on. The primary concern is the relationships between household type and property form.

A commentary on discrepancies between total dwelling counts and total occupied properties will not be made, with the sole focus being on the utilisation of dwellings. However, it is pertinent to point out that a little fewer than 600,000 households engaged with the Sydney housing market over the five year period 2006-2011. However, this only generated net demand for fewer than 100,000 properties. This value, of course, cannot represent inter-censual population trends. In particular, issues of growth and decline in demand between 2006 and 2011 cannot be captured. This represents a limitation to the research, and not one that can be readily overcome. Of specific interest, and an area for future research, would be the consideration of just how much of a potential effect an *ebbing and flowing* demand cohort has had on the production of new supply.

The spatial accounting method used in this section uses the eight HMDAs as sub regions within this overall activity, the profiles of those moving to the locations are used to assess expressed demand for

housing. For this purpose the following utilises two data resources to profile drivers within the market and their expressed demand. To ascertained how these flows eventuated into expressed demand the new time series data set (covering the period 2006-2011) has been used.

Mover profile by age-income

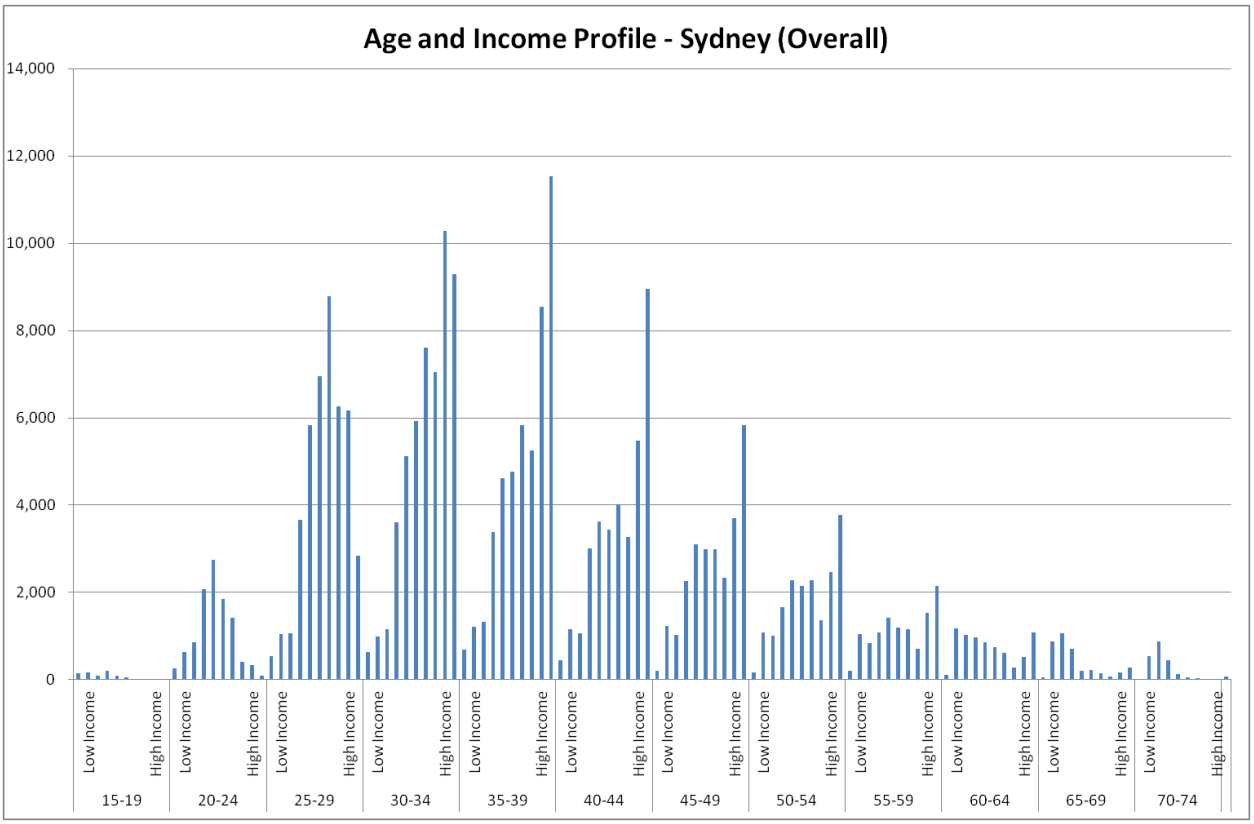
This section examines the profile of movers operation across Sydney and within the HMDAs. In keeping with the conceptual framework of housing career pathways used to construct this geography of housing markets, the profile of moves is predicated on a model of upward pressure flowing from younger to older households. To this end, when considering the profile of movers in line with age we would expect the following:

1. A broad upward trend in moves occurring across younger age cohorts;
2. A peak in moves occurring around age groups where family household formation is the greatest;
3. Declining numbers of moves after this peak as age increases.

Further to these trends we would also expect to see evidence of incomes increasing as age progresses (as people's careers in the labour market develop) and then a declining in the older age groups as retirement occurs and moves are facilitated by accrued capital.

As **Figure 11** illustrates, this is broadly the case at the Sydney level for the 553,986 household moves made during the period.

Figure 11: Age-Income Profile of household moves (Sydney Overall)



In Figure 11 we can see, as a whole, the age-income profile containing the greatest number of moving households comprised the high income 35-39 age group. This cohort was comprised of just fewer than 12,000 households, or around 2.2% of total movers. The second largest cohort was comprised of *marginally* less affluent households in the 30-34 age group (just over 10,000 households, or1.8%). A similar shift down the income profile (but still representing higher income earners) can be seen when the 25-29 age cohort is considered. In this group around 9,000 households earning medium-high incomes dominated the movement pattern. A general linear pattern can be seen between increasing income and increasing age, with the spikes of dominant movers in each cohort gradually shifting to the right of each group's income distribution profile; post 39 the affluent households continue to dominate the movement pattern, although at reduced levels overall. The upward income trajectory through the age cohorts is indicative of general life-course progression within the labour market. This generates conterminous upward pressures within the housing market (in general) as these households express new demand related to these income shifts.

Turning to the individual profiles of age-income moves in each HMDA, for each of these comparisons will be made to the overall profile set out in **Figure 11**[3].

Figure 12: Age-Income Profile of household moves (Western Sydney HMDA)

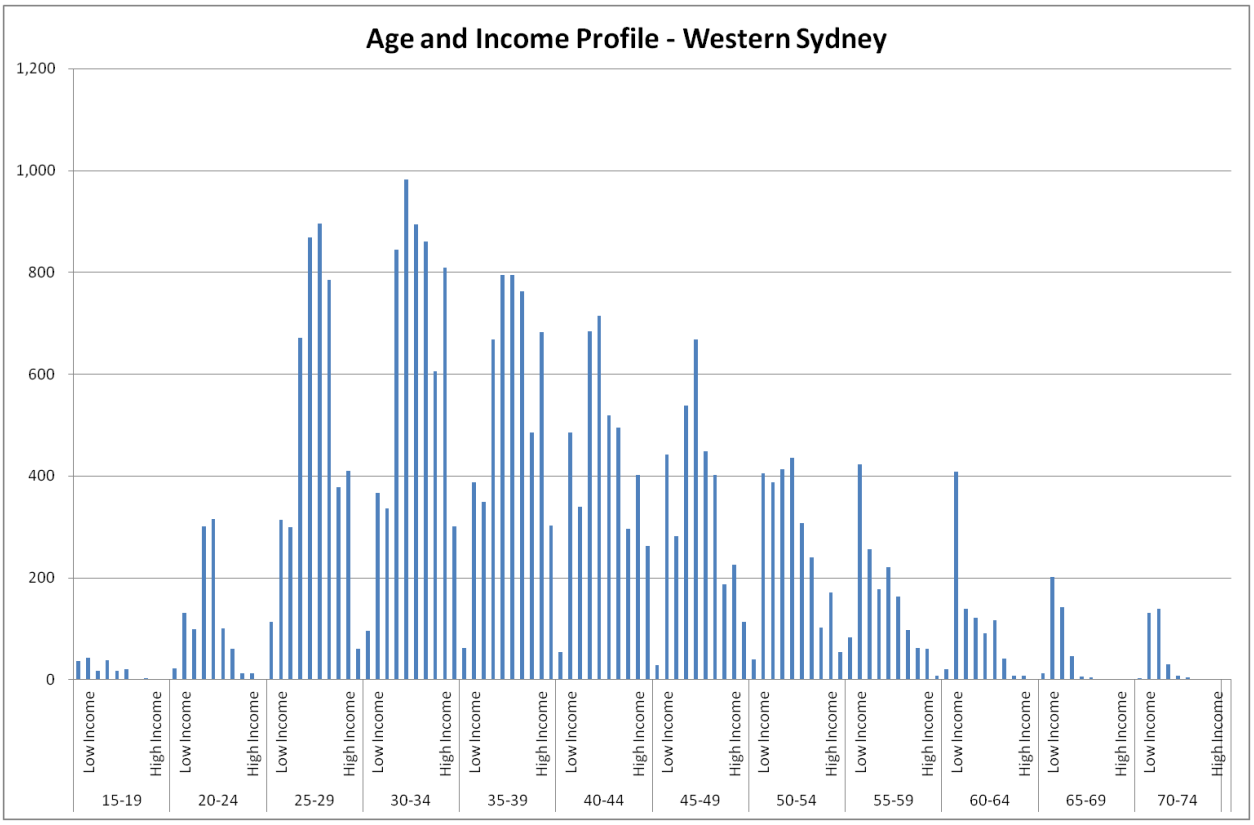


Figure 12 sets out the age-income profile for the Western Sydney HMDA. In comparisons to the overall market profile there are notable clusters of low to middle incomes *throughout* all age cohorts. Whilst numbers of movers increases rapidly through the younger age cohorts a notable feature within this HMDA is the decline in express demand post 34. This is in comparison to the profile seen for Sydney overall where demand remains strong through the post 34 age groups. Where in the overall market the high income 35-39 age group is the dominant profile, in Western Sydney there isn't such a distinctly dominant grouping. Indeed, there is a broad grouping (each comprising between 2-3% of overall moves) spread across the middle income ranges of the 25-29, 30-34 and 35-39 age groups. Of further note are the larger peaks in low income older households (55-59 and 60-64), indicating a greater level of mobility in older aged households within this HMDA then seen at the overall level.

[3] A tabulated version of the following graphs can be found in Appendix 3.

Figure 13: Age-Income Profile of household moves (South West Sydney HMDA)

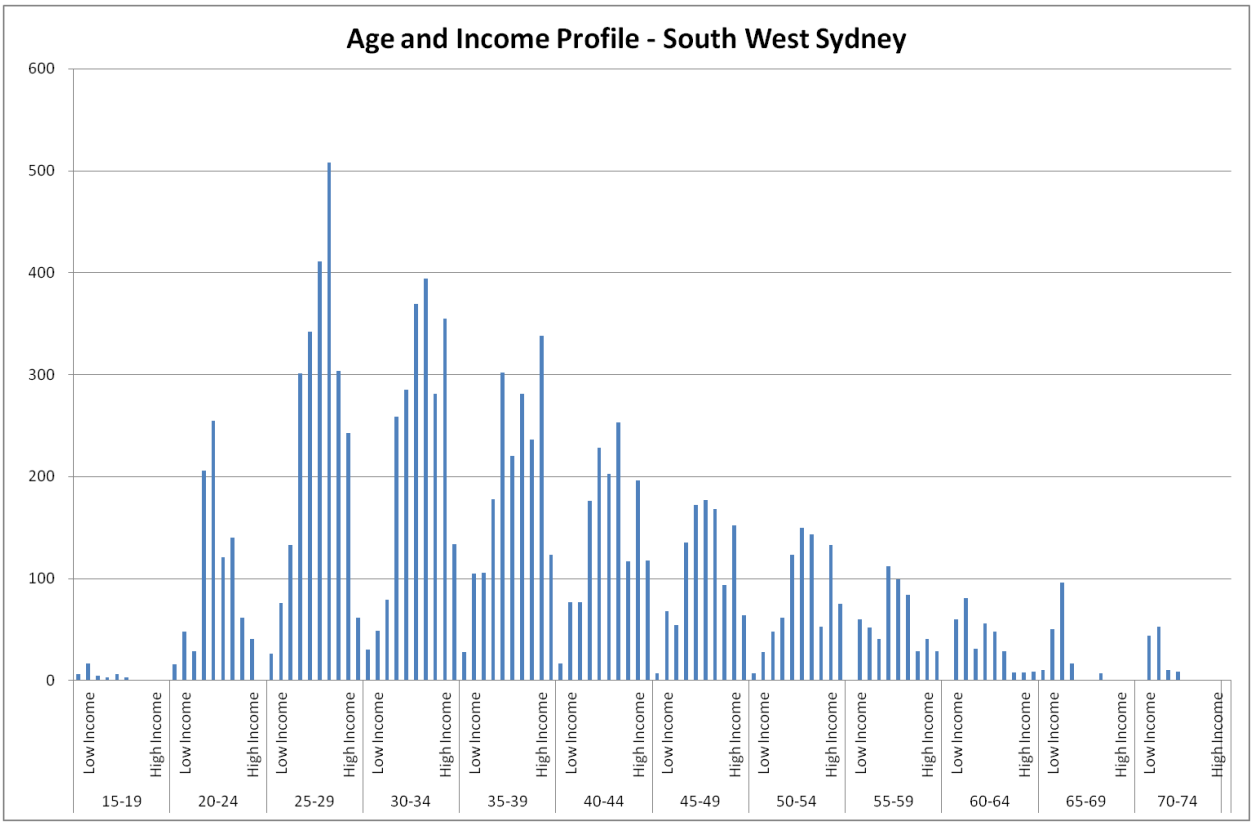


Figure 13 sets out the mover profile for South West Sydney. There is a notable clustering of low to middle incomes *throughout* all age cohorts. Whilst numbers of movers increases rapidly through the younger age cohorts a feature within this HMDA is the decline in express demand post 29. This is in comparison to the profile seen for Sydney overall where demand remains strong through the post 34 age groups. Within this pattern there is evidence of higher income older households (aged 35-39). This grouping, in all eventualities, represents the core demographic moving to the area's Greenfield locations. It is worth noting that this is a distinct profile operating within a region which is otherwise dominated by low income movement. However, whilst this peak is present, it should be noted that it only accounts for 2% of the overall mover profile occurring within the HMDA.

Figure 14: Age-Income Profile of household moves (Rural Fringe HMDA)

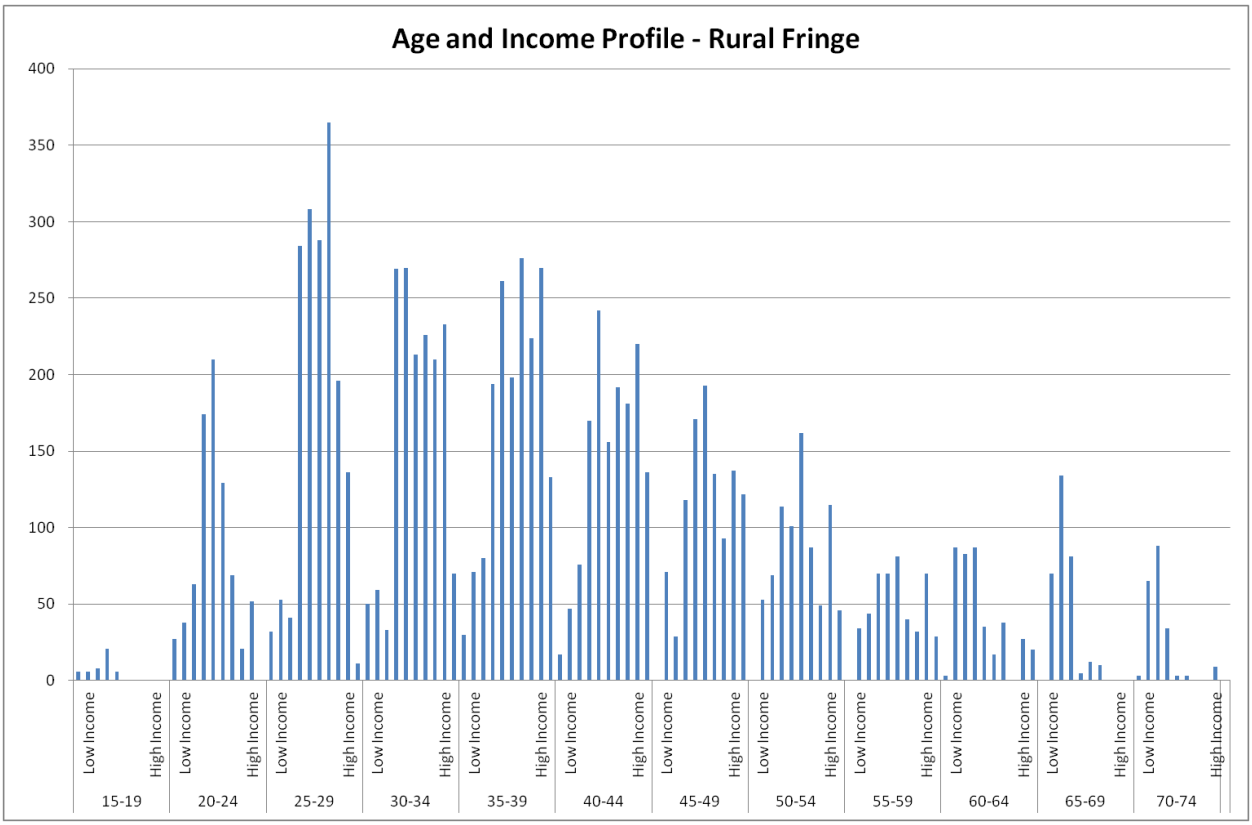
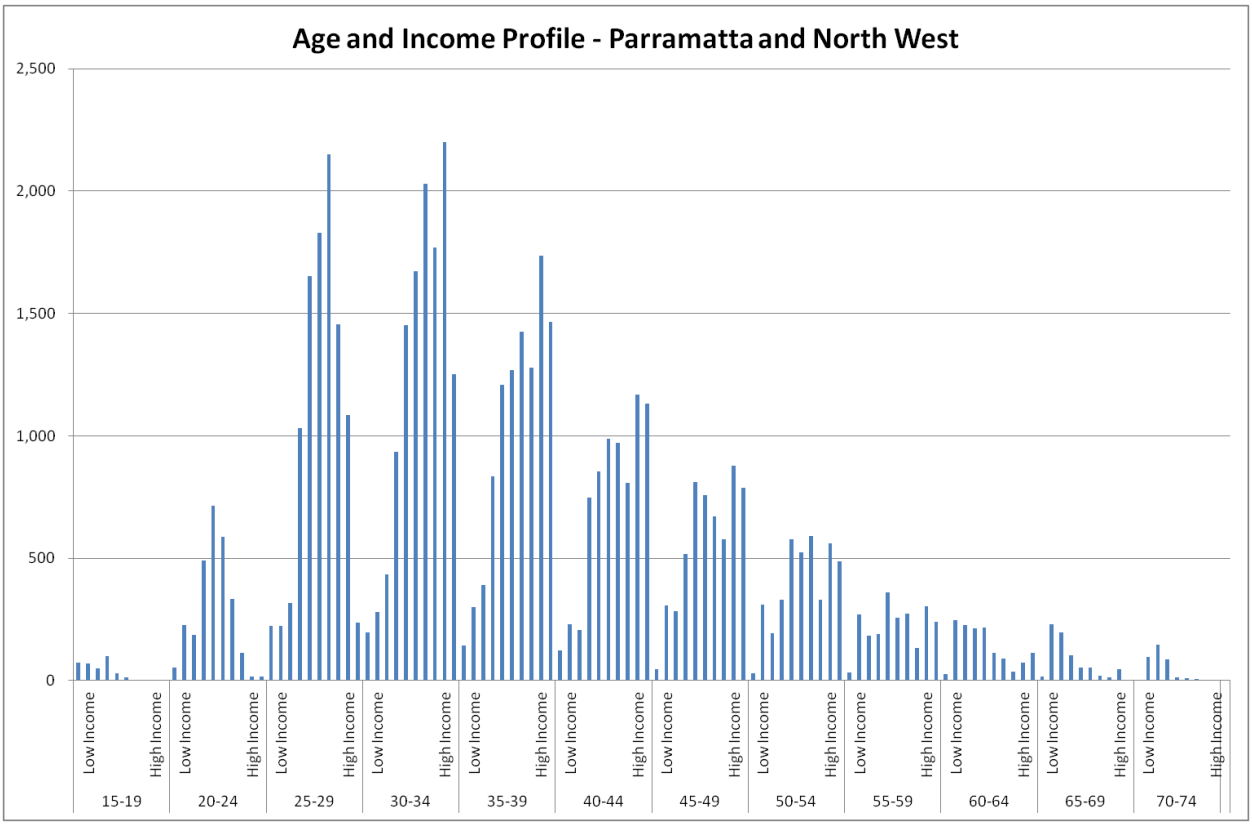


Figure 14 sets out the mover profile for the Rural Fringe HMDA. Given that this area is the largest in geographical scale and shares boarders with several of the other HMDAs there isn't as much variability in the overall mover profile as might be expected. One of the most notable features of the age-income movement profile is the dominance of younger (25-29) age cohorts which accounted for just over 10% of the overall movement occurring during the period. However, of note is that this peaks around middle income groupings. From this point forward the demand profile becomes bifurcated between low income movers and medium-higher income movers across all age cohorts. In the later stages a general pattern in the reduction in incomes can be seen, suggesting a retiree market process.

Figure 15: Age-Income Profile of household moves (Parramatta and North West HMDA)

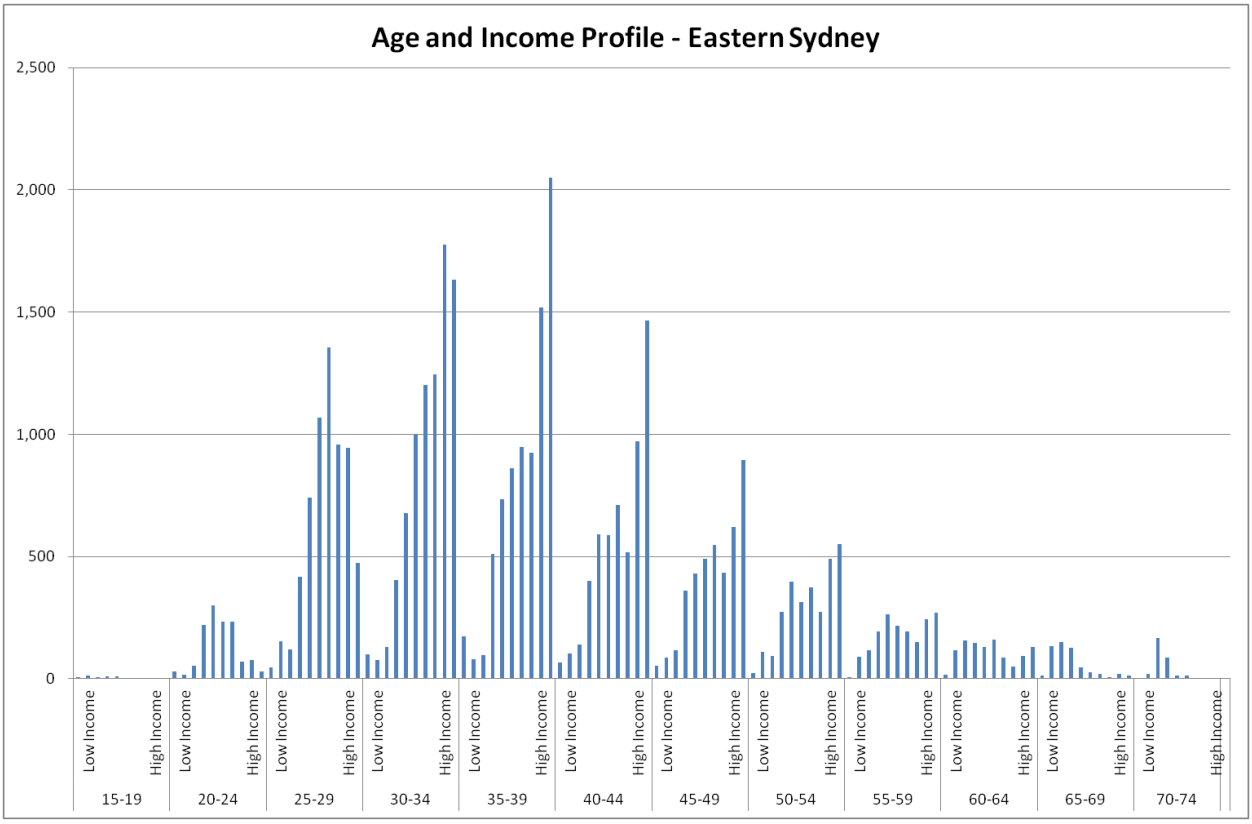


In **Figure 15** (movers in Parramatta and North West HMDA) there is a general liner progression upward through incomes that can be associated with housing career progressions operating throughout the HMDA. In comparison to Sydney's housing market overall, however, considerably greater levels of movement occurs within the younger age groups. Indeed almost 20% of movers were aged 25-29, with groupings around middle-high income brackets. A further 20% were aged 30-34, with clustering around marginally higher incomes. The housing career model of market operation in this HMDA would appear to be occurring slightly earlier than within the broader housing market at large.

Figure 16: Age-Income Profile of household moves (North Sydney (and Shore) HMDA)

Figure 16 profiles the age-income of movers to the North Sydney (and Shore) HMDA, movement through this HMDA is almost entirely dominated by very high income earning groups across all age cohorts. The 35-39 age groups (8% of total moves) exerted a massive level of demand during the period. In total the highest income groups (30-34 through to 45-49) comprised over a quarter of all moves. Further to this, and unlike the position overall, there isn't evidence of a backward shift in incomes during the early to late retirement periods. Indeed these groups, who will also have substantial amounts of accrued capital, continue to exhibit high incomes.

Figure 17: Age-Income Profile of household moves (Eastern Sydney HMDA)

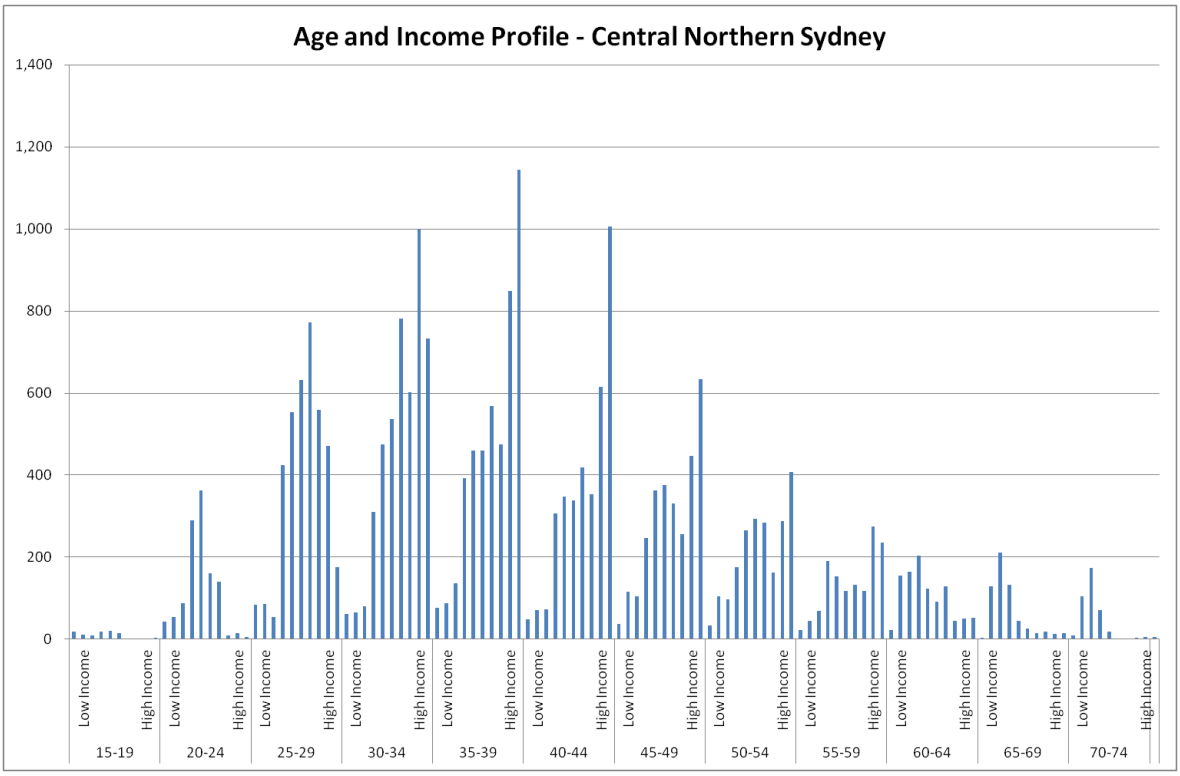


In the Eastern Sydney HMDA **(Figure 17**) there is evidence of high income earning 35-39 year olds driving demand. However there is also a clear upward trajectory in incomes within the younger age groups, and in combination the two highest earning groups in the 30-34 age cohort accounted for 8% of the overall movement occurring during the period. There would appear to be a transitionary process occurring within this younger age group which either drives incomes higher or begins to suppress ability to move due to the continued pressures in demand stemming from the continuation of high income cohorts throughout the older age groups.

Figure 18: Age-Income Profile of household moves (City and Harbour Side HMDA)

The City and Harbour Side HMDA profile of movers (**Figure 18**) is broadly comparable to the Eastern Sydney HMDA. However the demand stemming from the younger age cohorts (under 30) is notably split between medium-low and medium high groupings. After this the driving presence of extremely high incomes dominates across all other age profiles. The greatest volume of demand (10%) stemmed from the two highest income earning groups in the 30-34 age cohort, and this would appear to be driving a similar spike in the very high earning demand cohort in the 35-39 age group (6% of overall demand).

Figure 19: Age-Income Profile of household moves (Central Northern Sydney HMDA)



The profile of age-income movers in the Central Northern Sydney HMDA (**Figure 19**) is broadly comparable to the overall market in general. A broad linear trend can be seen with movement increasing as incomes grow between each age group, with the largest demand pressure coming from higher earning households in the 35-39 age groups; although this only accounts for a little over 4% of the total. Similarly to the overall pattern there is a reduction in incomes throughout the older age groupings.

To conclude this section the following considers the main patterns of moves by age and income operating within the HMDAs (**Figures 20** and **21**). More detail is provided on the following pages; however two of the most striking findings are the proximity in the majority of the dominant patterns and also that no discernibly strong patterns are observable in the income flows until higher incomes. One of the questions these findings raise concerns how do these discretely different age-income profiles express their demand?

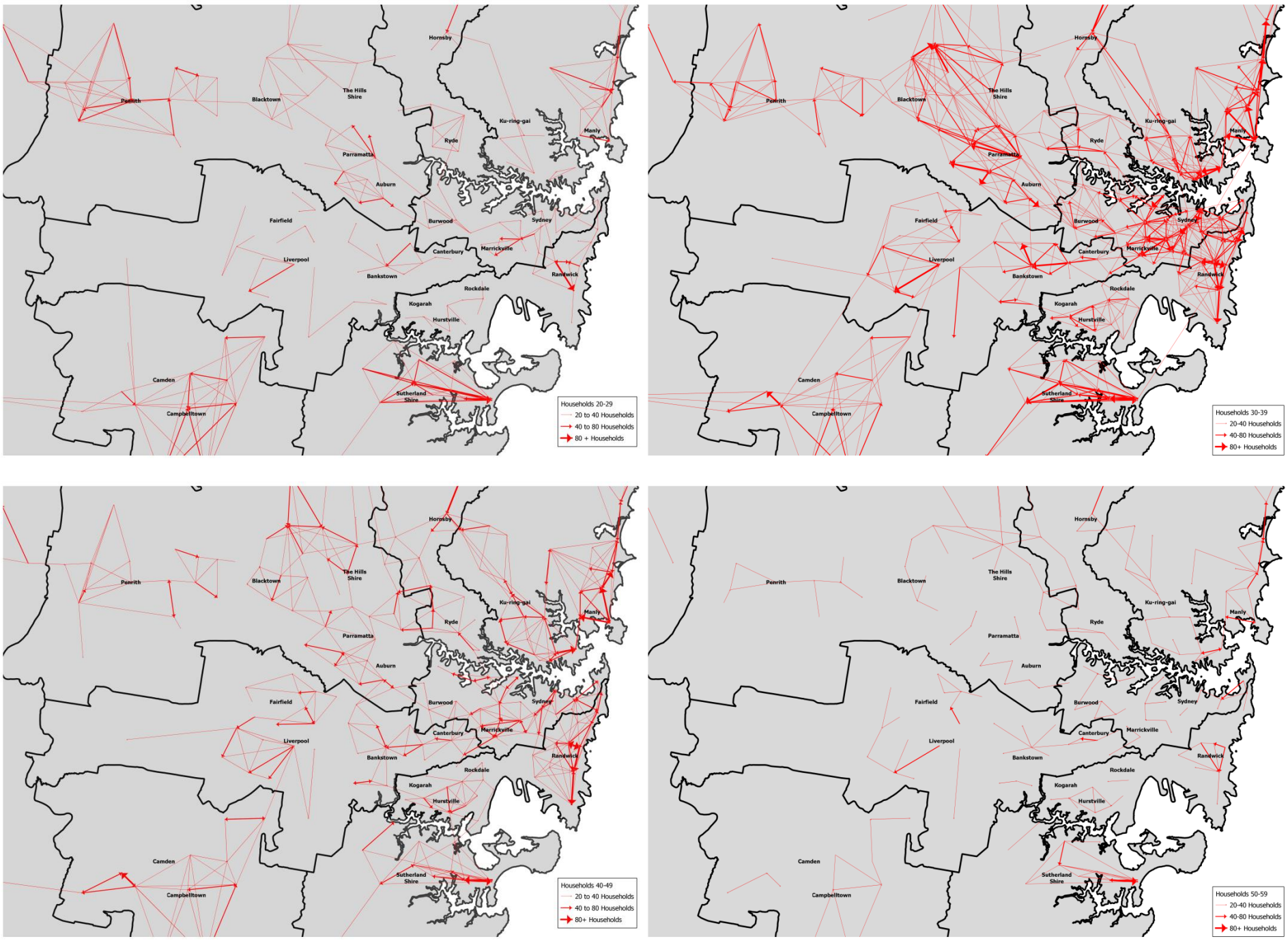


Figure 20: Age Cohort Flows

Figure 20 compares the overall scale of household moves by broad age cohort. Stating with the youngest grouping of 20-29 (top left) several specific trends can be observed. In orders of magnitude these are:

- A “conveyor” effect moving east to west (inland to the coast) in Sutherland Shire;
- Large numbers of households moving around Campbelltown specifically and the southwest in general
- A chain of moves with their centre based around Penrith
- Flows to Manly from inland, and emanating from Manly up the north shore
- A series of local moves emanating from central Parramatta
- A similar volume of local moves from the inner city to the inner west.

The 30-39 age group (top right), contains the greatest number of overall moves. Its general trends, again by order of magnitude, are:

- A series of chain movements starting in Parramatta and moving west into Blacktown and north west into the Hills district;
- A similar set of chain movements in operation westward from the city centre and southwards through the Eastern Suburbs;
- Intensification of the conveyor in Sutherland Shire;
- A similar intensification of moves along the north shore;
- Two, apparently independent, patterns in Western Sydney. With one moving westwards from Canterbury to Bankstown generating conterminous moves outward from central Bankstown. The second emanating from central Liverpool outwards to the western release areas;
- A strengthening in the churning pattern of moves around southwest Sydney.

The overall numbers of moves begin to decline in the 40-49 age group (bottom left), with many of the patterns described previously remaining in place but lower in magnitude. However, one effect of interest is the apparent strengthening of the moves outwards from central Liverpool. Finally, the 50-59 age group (bottom right) is the last group in which there are any desirable patterns within overall movement activity. Again many of the patterns of movement seen previously hold true.

Figure 21: Income Cohort Flows

One of the most noticeable facets of the profile of flows derived by income (**Figure 21**) is that there is that there is almost no declinable pattern within these[4]. Aside from the obvious clustering of high income level movers (described below), only three other income groupings (starting with moderate income earners and moving up the income profile) actually contained significant patterns of movement of 20 households or more. Starting with individual incomes of $52-$65,000 (top left), and in order of overall magnitude:

- Moves from the coast to inland locations in Sutherland Shire;
- Moves up the north shore emanating from Manly;
- A circuit of movement operating in the southwest;
- Similar chain movement from central Parramatta outwards towards Blacktown;
- Linked movement operating around Penrith;
- A series of isolated chains operating throughout Western Sydney;
- A nexus of flows operating in the Inner West;
- A similar nexus operating in the Eastern Suburbs.

In the $65-78,000 income grouping (top right) many of the profiles seen previously remain in operation. There are only two discernible differences; one of these is the almost complete absence of any large-scale moves in Western Sydney. The second is the beginnings of a highly localised, chain of moves ending in the North West's Greenfield locations. A similar intensification in the magnitude of moves can be seen as individual incomes increase into the $78-$104,000 bracket (bottom left).

In the high income-earning bracket, containing individual incomes of $104,000 or more (bottom right), the key observation is the proximity in the origins and destinations for the majority of the large-scale moves. A chain of movement moving northward from the lower north shore through Ku-ring-gai is one noticeable feature. Similar in overall volume is the nexus of moves in operation east of the city centre and linked in with moves southward through the eastern suburbs and westward through the inner west. There is hardly any evidence of large-scale moves occurring in Western Sydney. In the south west there is the presence of highly localised, but isolated, movement to Greenfield release locations.

[4] For this analysis the profile of RPI incomes has been used. This means that the values reported on are considerably lower than the *actual* household income of moving cohort (Lone Person households excluded). However, Appendix 1 demonstrates that there is a broadly comparable relationship between individual incomes and household incomes. This means that the patterns presented can be largely seen as relating to movement tied to household incomes.

Net Change in Occupied Residential Properties – Chains of Movement

The following section looks at the net change in overall number of occupied residential dwellings by family type. In it the overall patterns of movement discussed previously are considered as a chain of events, in which new supply acts to fill in the gaps occurring in the chain generated by growing demand. Net changes in occupied residential dwellings are therefore the outcome of chain movement facilitated by growing demand and new supply. It is not a count of new supply directly. Instead it, broadly, demonstrates the manner in which the overall housing market is adapting to changing demand.

Before detailing the changes in occupied residential property use, it is useful to consider how different households, at different stages of their housing career pathways may be expressing demand across Sydney. **Table 3** provides an overview of this, and presents the information in the form of a heat map. This presentation approach is used for the majority of the tabulated information in the remainder of the report; so by means of introduction, the colour scheme used runs from dark blue (lowest values) through light blue, through oranges and into red, with dark red identifying the highest values.

In **Table 3** we can see certain hotspots of demand being expressed by different age groups, in different locations and from different points of origin. In the Rural Fringe whilst demand is stemming mainly from households aged 30-39 coming from other locations in Sydney there are also pressures from local movers (within same HMDA) from younger (20-29) and older age groups. In Parramatta and the North West key demand groups are locally derived and in the age range 30-49, however there is also key pressure from younger households arriving from overseas and older (retiree aged) households arriving from elsewhere in Australia. Similar patterns of demand can be seen in North Sydney (and Shore) and the City and Harbour Side HMDAs, of note, however is the lower presence of older moving households. Eastern Sydney HMDA is driven by locally based movers in the 30-39 age groups. Central Northern Sydney experienced demand from the 30-39 age groups as well, although with notable pressures coming from movers previously overseas. Interestingly, a similar profile can be seen also in South West Sydney and Western Sydney. Given the differences in overall population composition in these three areas (income not withstanding) could these similarities in age profiles be driving similar or different patterns of demand for housing?

One means to unpack this further is to consider the specific household profiles that these age groups relate to. In doing so, how demand is being expressed by location, can be considered. It is these relationships that this section now goes on to explore.

Table 3: HMDA movers profile by age (2006-2011)

	Location 5 Years Previously	15-19	20-29	30-39	40-49	50-59	60-69	70-74
Rural Fringe	Mover within same HMDA							
	Mover from different HMDA							
	Mover from elsewhere in Australia							
	Mover from Overseas							
Parramatta and North West	Mover within same HMDA							
	Mover from different HMDA							
	Mover from elsewhere in Australia							
	Mover from Overseas							
North Sydney (and Shore)	Mover within same HMDA							
	Mover from different HMDA							
	Mover from elsewhere in Australia							
	Mover from Overseas							
City and Harbor Side	Mover within same HMDA							
	Mover from different HMDA							
	Mover from elsewhere in Australia							
	Mover from Overseas							
Eastern Sydney	Mover within same HMDA							
	Mover from different HMDA							
	Mover from elsewhere in Australia							
	Mover from Overseas							
Central Northern Sydney	Mover within same HMDA							
	Mover from different HMDA							
	Mover from elsewhere in Australia							
	Mover from Overseas							
South West Sydney	Mover within same HMDA							
	Mover from different HMDA							
	Mover from elsewhere in Australia							
	Mover from Overseas							
Western Sydney	Mover within same HMDA							
	Mover from different HMDA							
	Mover from elsewhere in Australia							
	Mover from Overseas							

As **Table 4** demonstrates there are considerably different trajectories in the overall numbers of occupied properties in Sydney. Between 2006 and 2011 a little over 98,114 occupied properties were added to Sydney's stock. Discrepancies between this value and those reported in other resources stem both from the fact this count is of actual occupied properties, coupled with this the value includes existing properties returned to use and also conversions and de-conversions of existing properties. At an annualised rate, this is a little over 19,600 properties per year, or a growth rate of around ~1% (5.3% for the period). It should be noted that observed growth or declines within each of the household profiles also represents changes occurring within households, which will not always be tied to movement. For example, growth in Couple families without Children will also capture declines in the number of Couple families with Children (i.e. when a child leaves home and the parents don't move the count of Couple Families with Children decreases by one and the count of Couple Families without Children increases by one). Similarly, increases in Lone Person households (especially in Separate Houses) will also capture households previously classified as Couple Families without Children where a partner or spouse has died. To this end, the values presented contain both growth and change in household compositions. Notably, however, is that the number of Couple Families with children grew substantially more than other forms of household types. Indeed, there was a net overall decline in the numbers of Lone Person households in lower density flats and apartments.

Table 4: Overall Net Changes in Occupied Residential Dwellings by Family Type

Sydney Total	Separat e house	Semi-detached row or terrace house townhouse	Flat unit or apartment In a one or two storey block	Flat unit or apartment In a three storey block	Flat unit or apartment In a four or more storey block	**Total**
Couple family with no children	2310	4104	2059	5589	11541	**25603**
Couple family with children	9897	12474	2505	5651	7619	**38146**
One parent family	5854	2662	89	1667	1944	**12216**
Other family	411	230	-13	55	434	**1117**
Lone person	1695	5133	-1083	1377	8631	**15753**
Group household	271	1152	29	899	2928	**5279**
Total	**20438**	**25755**	**3586**	**15238**	**33097**	**98114**

The single largest net growth was seen within Couple Families with children living in Semi-detached, Terraced or Townhouses (termed "attached houses" from this point forward) and accounted for almost 13% of overall growth. Given that this sector of supply is smaller in scale than the detached house sector the lower (in absolute terms) growth rate in the numbers of Couple Families with children in Separate Houses (10% overall) is a notable feature. Another facet revealed by the analysis is the striking growth in the number of single parent families, especially within the detached property sector (representing almost

50% of this group. A speculation here is that part of this growth will be due to marriage breakdowns or similar family dissolution. Just less than 12% of total growth is accounted for by increases in the numbers of Couple Families without Children living in high-density apartments. Also of note in the high-density sector is that the numbers of Lone Persons *and* Couple Families with Children grew in comparable size. The same thing cannot be said for the three-storey apartment sector where the dominant growth has been drawn from Couple Families both with and without children.

Before moving on to discuss net changes by HMDA it is useful to first consider changes within the property form in which these families and households live. As **Table 5** demonstrates there are considerably different trajectories between the HMDAs when these net changes are considered separately. Of note is the role both attached houses and flats / units have played in facilitating the bulk of the net changes seen within the housing market in general. Notably, the role of attached housing in Western Sydney, Parramatta and North West and out in the Rural Fringe is greater than in the HMDAs containing many of the older suburbs that comprise the bulk of this property form. Flats and Units appear to play the same role in South West Sydney and also in Parramatta and North West. Declines seen in the percentage of Detached Houses in Eastern Sydney the City and Harbour Side are, probably, being driven by lot amalgamation for supply consolidation.

Table 5: Overall Change in percentage of occupied residential properties

HMDA	Total	Flats and Units	Attached Houses	Detached Houses
Western Sydney	4.9%	8.9%	21.0%	1.3%
South West Sydney	5.7%	37.0%	4.0%	4.9%
Rural Fringe	4.8%	-7.6%	29.9%	4.3%
Parramatta and North West	7.5%	21.0%	24.0%	3.2%
North Sydney (and Shore)	4.7%	9.6%	13.5%	0.4%
Eastern Sydney	3.6%	7.5%	7.5%	-0.4%
City and Harbour Side	6.3%	9.9%	8.0%	-2.4%
Central Northern Sydney	3.6%	11.5%	8.2%	0.9%

Turning to the changes in net household use of property forms by HMDA; **Table 6** sets out the changes seen in Western Sydney. The relative dominance of Couple Families with Children in attached houses seen at the city level (**Table 4**) is present. Notably there has been an absolute *decline* in the numbers of Couple Families without Children in detached housing, suggesting that a certain level of replacement is occurring due to older households either moving or (in all reality) dying. Given that Western Sydney contained only 10% of the overall net change in occupied dwellings the levels in growth of One Parent Families in detached properties and declines in the numbers of Lone Persons in lower density units is notable as both represent over a third of overall trends.

Table 6: Net Changes in Occupied Residential Dwellings by Family Type (Western Sydney)

Western Sydney	Separate house	Semi-detached row or terrace house townhouse	Flat unit or apartment In a one or two storey block	Flat unit or apartment In a three storey block	Flat unit or apartment In a four or more storey block	
Couple family with no children	-276	695	280	257	380	**1336**
Couple family with children	746	2664	404	481	684	**4979**
One parent family	1639	831	-9	231	230	**2922**
Other family	137	46	53	-6	22	**252**
Lone person	96	750	-356	65	319	**874**
Group household	88	115	31	22	51	**307**
Total	**2430**	**5101**	**403**	**1050**	**1686**	**10670**

Table 7: Net Changes in Occupied Residential Dwellings by Family Type (South West Sydney)

South West Sydney	Separate house	Semi-detached row or terrace house townhouse	Flat unit or apartment In a one or two storey block	Flat unit or apartment In a three storey block	Flat unit or apartment In a four or more storey block	
Couple family with no children	1130	249	30	98	61	**1568**
Couple family with children	245	307	6	23	13	**594**
One parent family	656	-422	-3	7	4	**242**
Other family	84	12	8	3	0	**107**
Lone person	646	217	100	142	29	**1134**
Group household	104	62	7	9	0	**182**
Total	**2865**	**425**	**148**	**282**	**107**	**3827**

In the South West Sydney HMDA (**Table 7**) the largest overall trend is the growth in smaller household types living in detached houses. Indeed, almost 30% of net changes are accounted for by the growth in the numbers of Couple Families without children in this property form. The declines in the number of One Parent Families in attached housing is striking, although this is probably a one off event due in part to the renewal of the Bonnyrigg Estate.

Table 8: Net Changes in Occupied Residential Dwellings by Family Type (Rural Fringe)

Rural Fringe	Separate house	Semi-detached row or terrace house townhouse	Flat unit or apartment In a one or two storey block	Flat unit or apartment In a three storey block	Flat unit or apartment In a four or more storey block	
Couple family with no children	1111	265	-23	-7	0	**1346**
Couple family with children	223	106	-20	12	1	**322**
One parent family	803	200	12	15	9	**1039**
Other family	80	3	-13	3	0	**73**
Lone person	1154	673	-152	-12	16	**1679**
Group household	61	24	-8	6	0	**83**
Total	**3432**	**1271**	**-204**	**17**	**26**	**4542**

The increasing presence of smaller households in detached house property forms appears to be the main outcome of housing market process operating in the Rural Fringe HMDA (**Table 8**). Of further note are also the increases in the numbers of Lone Person households in forms of attached housing. Combined, this represents an increasing underutilisation of larger properties in over 80% of all housing market outcomes in this HMDA.

Table 9: Net Changes in Occupied Residential Dwellings by Family Type (Parramatta and North West)

Parramatta and North West	Separate house	Semi-detached row or terrace house townhouse	Flat unit or apartment In a one or two storey block	Flat unit or apartment In a three storey block	Flat unit or apartment In a four or more storey block	
Couple family with no children	1618	1202	581	1280	1184	**5865**
Couple family with children	3601	4004	937	1765	1123	**11430**
One parent family	1621	734	124	458	155	**3092**
Other family	223	117	24	116	36	**516**
Lone person	1121	1297	-159	523	448	**3230**
Group household	243	96	74	89	99	**601**
Total	**8427**	**7450**	**1581**	**4231**	**3045**	**24734**

Large increases in the overall numbers of Couple of Families with Children both in detached and attached houses is the central feature of housing market outcomes in the Parramatta and North West HMDA (**Table 9**). Aside from the moderate increases in Couple Families without Children in flatted properties of 4 stories or more, the broad profile of net change in this HMDA is comparable to those seen at the city level. One notable feature is, however, the presence of Group Households in detached property forms. The net change in this profile accounts for almost 90% of the change seen across the city as a whole.

Table 10: Net Changes in Occupied Residential Dwellings by Family Type (North Sydney (and Shore))

North Sydney (and Shore)	Separate house	Semi-detached row or terrace house townhouse	Flat unit or apartment In a one or two storey block	Flat unit or apartment In a three storey block	Flat unit or apartment In a four or more storey block	
Couple family with no children	-649	401	522	953	1644	**2871**
Couple family with children	2357	1035	509	1067	1540	**6508**
One parent family	35	277	152	215	472	**1151**
Other family	-61	-8	-38	4	37	**-66**
Lone person	-629	359	424	214	729	**1097**
Group household	-240	58	-48	43	136	**-51**
Total	**813**	**2122**	**1521**	**2496**	**4558**	**11510**

A conterminous decreases in the numbers of Couple Families with no Children and Lone Person households and increases in the numbers of Couple Families with children in detached housing can be seen in the North Sydney (and Shore) HMDA (**Table 10**). This indicates that a large amount of the housing market outcomes operating in the HMDA were related to intergenerational change. However, it is also notable that the increase in numbers of Couple Families with children in higher-density flatted developments is roughly double the rates seen at the city level.

Table 11: Net Changes in Occupied Residential Dwellings by Family Type (Eastern Sydney)

Eastern Sydney	Separate house	Semi-detached row or terrace house townhouse	Flat unit or apartment In a one or two storey block	Flat unit or apartment In a three storey block	Flat unit or apartment In a four or more storey block	
Couple family with no children	-256	333	75	1490	1813	**3455**
Couple family with children	734	1558	429	1435	1135	**5291**
One parent family	437	255	-173	562	190	**1271**
Other family	-61	11	21	-50	54	**-25**
Lone person	-603	388	-1002	831	1192	**806**
Group household	14	90	-102	362	649	**1013**
Total	**265**	**2635**	**-752**	**4630**	**5033**	**11811**

Whilst much of the net change seen in the Eastern Sydney HMDA (**Table 11**) is associated with the higher-density sector there are also notable relationships between Couple Families with Children and forms of attached housing. However, as noted earlier, despite this HMDA containing a sizable proportion of Sydney's attached housing the level of growth in this relationship is actually *weaker* than might be expected. Taken together the net increases in the numbers of Couple Families with Children in the higher density forms of properties is considerably greater. Two other notable features are the presence of intergenerational change occurring in the detached housing sector (decreases of Couple Families without Children and Lone Persons, increases of Couple Families with Children) and also the substantial declines seen in Lone Persons in smaller flat and unit developments, comprising over 90% of all net declines reported in Table 4.

In the City and Harbour Side HMDA (**Table 12**) the influence of higher density properties dominates net outcomes overall. Here many of the outcomes appear to be driven by smaller households (Couple Families without Children and Lone Persons) moving into smaller, higher density, flats, units or apartments. There is evidence of intergenerational trading occurring in the detached housing sector. Although the numbers of Couple Families with Children moving into attached housing is numerically greater than in the Eastern Suburbs, it is proportionally smaller at less than 10% of overall activity.

Table 12: Net Changes in Occupied Residential Dwellings by Family Type (City and Harbour Side)

City and Harbour Side	Separate house	Semi-detached row or terrace house townhouse	Flat unit or apartment In a one or two storey block	Flat unit or apartment In a three storey block	Flat unit or apartment In a four or more storey block	
Couple family with no children	-429	752	405	1207	5453	**7388**
Couple family with children	710	2062	148	634	2126	**5680**
One parent family	32	508	-89	177	553	**1181**
Other family	5	55	-68	68	225	**285**
Lone person	-530	716	-95	-46	5203	**5248**
Group household	-15	647	19	375	1810	**2836**
Total	**-227**	**4740**	**320**	**2415**	**15370**	**22618**

Table 13: Net Changes in Occupied Residential Dwellings by Family Type (Central Northern Sydney)

Central Northern Sydney	Separate house	Semi-detached row or terrace house townhouse	Flat unit or apartment In a one or two storey block	Flat unit or apartment In a three storey block	Flat unit or apartment In a four or more storey block	
Couple family with no children	61	207	189	311	1006	**1774**
Couple family with children	1281	738	92	234	997	**3342**
One parent family	631	279	75	2	331	**1318**
Other family	4	-6	0	-83	60	**-25**
Lone person	440	733	157	-340	695	**1685**
Group household	16	60	56	-7	183	**308**
Total	**2433**	**2011**	**569**	**117**	**3272**	**8402**

Largely the net changes seen in Central Northern Sydney (**Table 13**) are comparable in distribution to those seen at the city level. Proportionally, the net change in the numbers of Couple Families with Children in detached houses is the highest in this HMDA suggesting a general level of affluence amongst this group. Of further interest, however, is the proportion of Couple Families with Children in four or more storey apartment blocks, at 11% of the overall net changes this is some 70% higher than rates seen across the city more broadly. There would appear to be a bifurcation occurring based on affordability constraints, between different income profiles within this group.

This section has demonstrated that if there is one discernible pattern of housing market outcomes currently in operation across Sydney it is, above all, a shift to medium density housing. Unsurprisingly, the main drivers of this are Couple Families with children, those with the most need to balance affordability with space. There is, of course, evidence of intergenerational change occurring within the existing detached property sector but it is important to point out that this appears to be facilitated by two distinct profiles.

The first is earning capacity amongst Couple Families with Children, and indeed much of this activity is being conducted within HMDAs that have relatively high-income profiles. The second is the ability for many of the current residents of detached housing to secure properties to downsize to within their current HMDA. In other words, locations enabling older households to move from larger family housing but still retain links to neighbourhoods and suburbs in which they currently live. Where medium density supply is limited or where incomes cannot support the purchase, there is evidence of Families with children ending up in higher-density property forms. Whilst this is outcome is largest (in numerical terms) in the Eastern Sydney, City and Harbour Side HMDAs it is proportionally larger in Western Sydney and Parramatta and the North West.

Supply analysis

The preceding two sections have illustrated the nature of mobility patterns operating in Sydney and the net housing market outcomes these chains of mobility have led to. Two main features have presented themselves. The first is the patterns of locality embedded in movement. The second, the dependency that overall market function has on Couple Families with Children to fundamentally drive function. However, what has been missing up to this point is any real evidence of these movement patterns and the chains they drive acting in concert with underlying supply profiles. It is this that the following section seeks to address. To undertake this, the HMSA geography (described earlier) is reintroduced.

Table 14 and **Figure 22** set out the 11 main flows that can be identified and presented in the context of their relationship to underlying HMSA profiles. This is then utilised to frame the nature of these dynamics as they relate to housing market processes.

Flows labelled 1, 6, 10 and 11 captures the role of the urban fringe (those representing the traditional mode of suburbanised supply) and its relationships to the rest of the city. It is evident from the analysis that these three locations function in distinctly different ways when the locations they draw demand from are assessed.

The North West release area (termination of flows 10 and 11) is well provided for in terms of moves emanating from Parramatta. The Western release area (flow 6) still draws from a movement chain operating from within its own area of functional demand (flow 5).

The South West release (termination of flow 1), at least in terms of its relationship to the rest of the city, draws demand from an isolated geographical area with no evidence of strong flows backfilling the initial pool of demand.

There is another noticeable pattern present within this geography, with the majority of the main flows overlapping locations of both higher density and lower density. This observation suggests that a large component of these moves comprise households moving from higher density (and cheaper) property forms into surrounding lower suburban locations. Whilst this conforms to career pathway considerations of housing market dynamics, the point to stress is that the vast majority retain a relative proximity to their starting point.

Considering the nature of these relationships in terms of overall housing careers, the first dynamic is representative of younger family households moving out of apartments (where they have either been renting or initially purchasing) and into houses. The second dynamic is representative of more established family households trading up into larger family homes. These two dynamics form the linchpin of overall housing market functionality: essentially driven by the trading up into larger property forms as families become larger and more established. The fact that the main flows and their relationships to the underlying supply dynamics reassert this should not come as any surprise. However, such dynamics generally do

not cross between the broad geographies of demand outlined; less than a third of overall demand shifts occurred between different HMDAs. This final observation serves to underline the local nature of the majority of housing market processes.

Table 14: Main flows operating within HMDAs

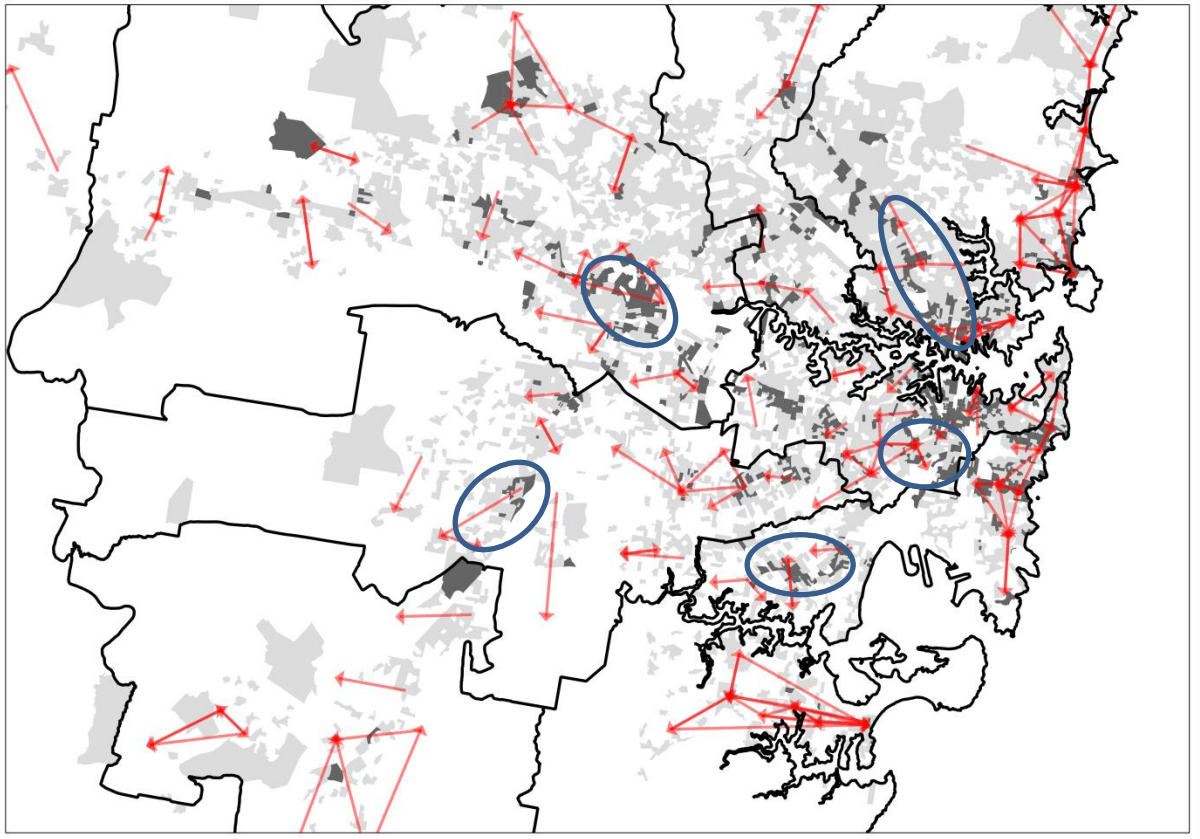
Flow	Origin	Destination
1	**Campbelltown** (Low Price, Low Density, Rental)	**Camden** (Medium Price, Lower Density, Home Ownership)
2	**Kogarah** (Medium Price High Density, Rental)	**Sutherland Shire** (High Price, Lower Density, Home Ownership)
3	**Kogarah** (Medium Price High Density, Rental)	**Hurstville** (Medium Price, Mixed Density)
4	**South Sydney** (High Price, High Density, Rental)	**Marrickville** (High Price, Mixed Density, Mixed Tenure)
5	**Canterbury** (Medium Price, Mixed Density, Mixed Tenure)	**Bankstown** (Low Price, Mixed Density, Mixed Tenure)
6	**Fairfield** (Low cost, Low Density, Mixed Tenure)	**Liverpool (West)** (Medium Price, Low Density, Home Ownership)
7	**North Sydney** (High Price, High Density, Rental)	**Ku-ring-gai** (High Price, Lower Density, Home Ownership)
8	**Parramatta** (Medium Price, High Density, Rental)	**Auburn** (Low Cost, Lower Density, Mixed Tenure)
9	**Parramatta** (Medium Price, High Density, Rental)	**Blacktown** (Medium Cost, Lower Density, Home Ownership)
10	**Parramatta** (Medium Price, High Density, Rental)	**Baulkham Hills** (High Cost, Low Density, Home Ownership)
11	**Blacktown** (Medium Cost, Lower Density, Home Ownership)	**Baulkham Hills** (High Cost, Low Density, Home Ownership)

Figure 22: Main flows operating within HMDAs

International immigration

Picking up on the lack of obvious movement into the core areas that represent the start of many of the main flows in Sydney this section, considers the impact from contemporary patterns of international immigration within the city. During the period 2006-2011 an additional 96,710 households arrived in Sydney from overseas representing around 17.5% of the total growth in households during this period. It should be noted that this value contains a count of return migration (i.e. Australian residents who were previously living overseas) as well as brand new households. Whilst it is difficult to unpick the numbers of these households which were return migrants and those which represent brand new demand, it is possible to map the key locations where the majority of these overseas households choose to locate. **Figure 23** presents concentrations of 50 or more households as dark grey.

Figure 23: Key concentrations of 50 or mores households who were previously living overseas and main movement dynamics (2006-2011)

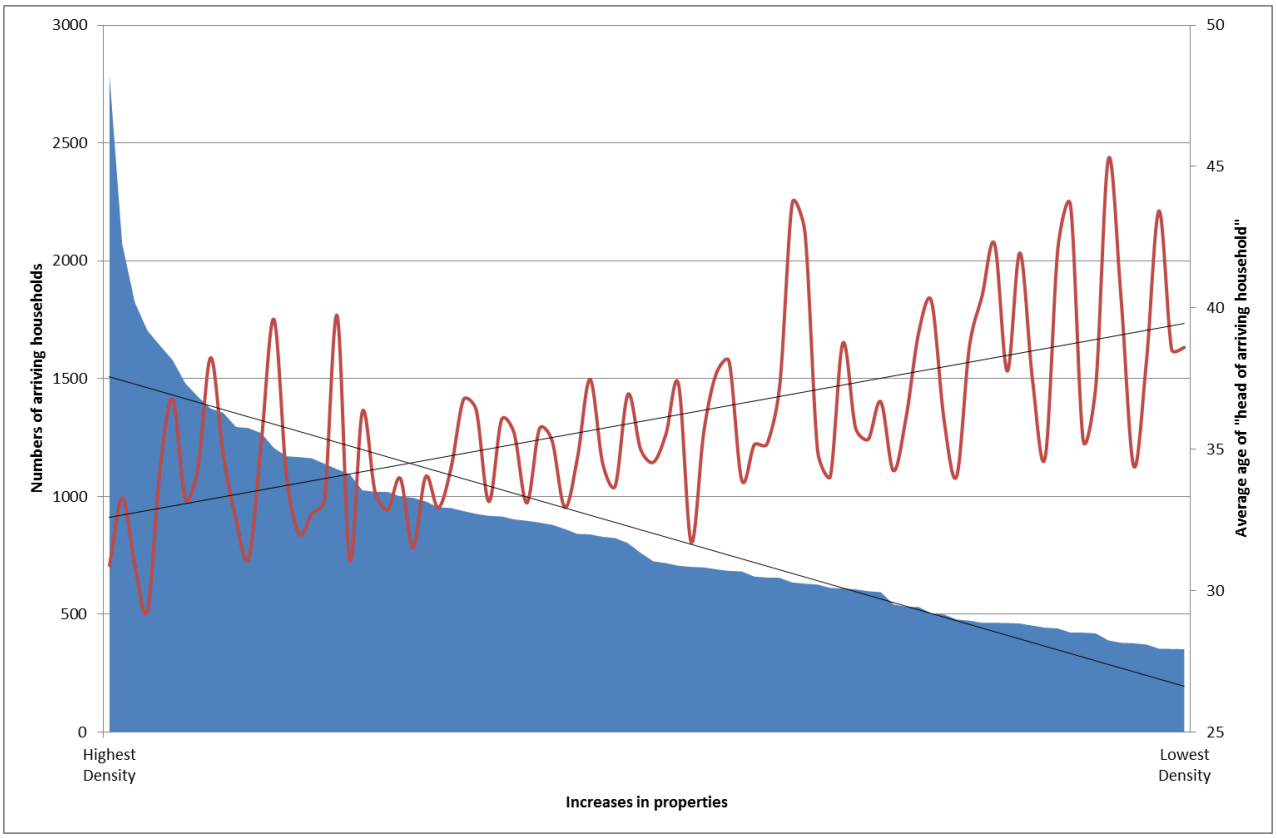


Overlaying these concentrations in **Figure 23** are the main movement dynamics operating in Sydney. An overview of these was seen **in Figure 22**; here they are presented in more detail. For legibility, locations have been marked (blue circles) where there is an intersection between the presence of international migration and the start of many of the main flows identified previously. As can be seen there is a relatively strong visual correlation between these two dynamics in the inner city, around Kogarah, flowing from

Central Parramatta and moving northwards from North Sydney. Many of these key hotspots of international migration appear to be meshing into the observable main flow dynamics operating within the city, essentially providing a demographic back filling of population within the locations experiencing the greatest outflows.

To illuminate this point further**, Figure 24** plots the number of households arriving from overseas (left hand axis) against the number of properties by location. The gradient between the two is quite marked. Also included in **Figure 24** is the relationship between density and the average age of the "head of household" in these arriving properties. While this relationship fluctuates a reasonable amount there is a broadly positive trend evident, the older the household the greater the relationship to lower density locations.

Figure: 24: Broad relationship between density, age and numbers of immigrant households



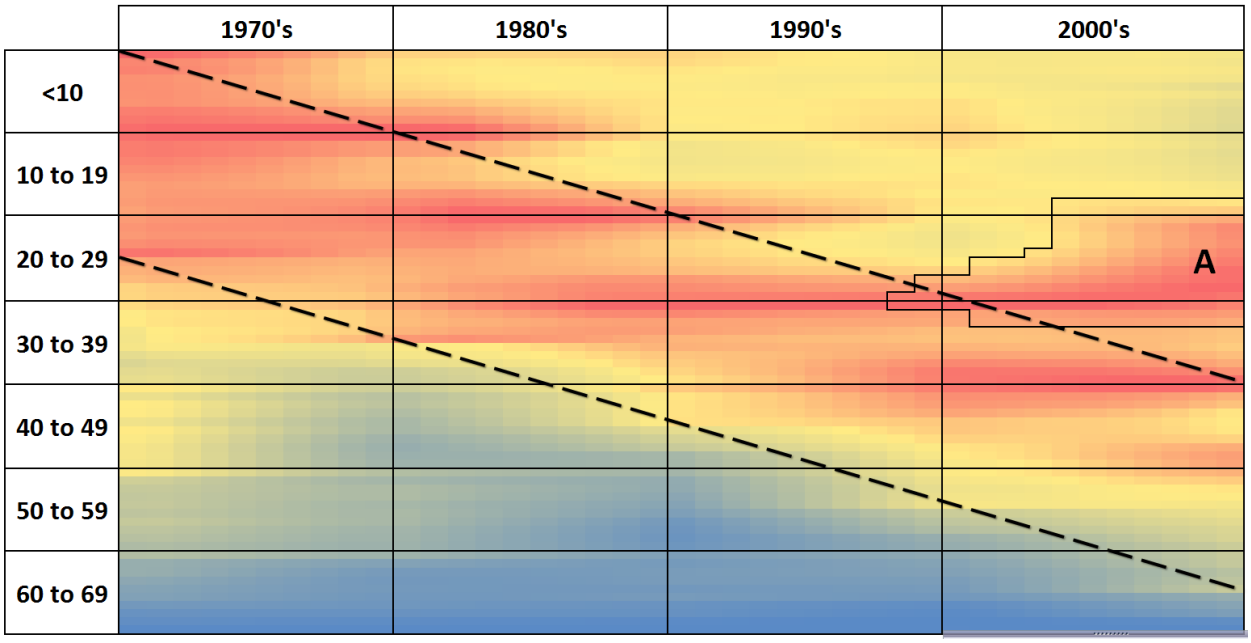
Using Housing Markets for analysis: Conclusions

The preceding sections have demonstrated how Sydney's Housing Market functions in terms of movement. They have done so by using the geographies developed from patterns of movement and a process of spatial accounting where-in key demographic profiles have been identified at work across the city. It has been demonstrated that housing career pathways provide one of the most dominant forms of demand in operation within Sydney. In turn these have been related to the interactions these profiles have within the geographies of supply. This analysis provided insight into the role medium density is playing in facilitating many mid-career demand pressures. It also identified the impact newer higher density supply is playing as the starting point for many of the housing career pathways. By considering where flows into this component of the market are coming from the impact of international migration came to the fore. It is this facet that the following conclusion basis most of its discussion on.

To get a handle on the potential impact international immigration may be having on the overall functionality of Sydney's Housing Market, it is important to think about *where* in their housing career many of the immigrants might be. Coupled with this, it is also important to consider whether this pressure is similar or different in nature to the broader population at large. Sydney has, of course, been dependant on international immigration for much of its history. However, running coterminous to this are patterns of broad demographic transition within the bulk of the resident population. One central facet of this demographic transition over the last forty years has been the scale and size of the baby boom population. Thinking back to the demonstrated role housing careers have in shaping housing market functionality it is essential to realise that much of the city's housing market functionality (and indeed, geography) has been predicated on and shape by the scale of this particular generation.

Figure 25 maps out the composition of Sydney's population by age from 1971 through to 2011. Each single age is presented as the percentage within the overall population by year; the colour scheme runs from blue (<1%) through to dark red (~2.5%). The parallel black dotted lines running through the figure represent the leading edge of the baby boom cohort (beginning in 1946) and its trailing end (persons born in 1964). The sheer size of this cohort can be seen progressing through Sydney's demographic structure with broad red bandings running through out.

Figure 25: Changing demographic profile of Sydney 1971-2011



So far this progression demonstrates the gradual ageing of the city. However, from the mid 1990's onwards this transition begins to fragment. A major demographic grouping can be discerned (marked A on Figure 25); a gradual reintroduction of a core demographic aged 20-29. It is almost as if this core demographic has arrived from nowhere as there is not really any presence of it earlier on (Figure 25 Co1). Whilst a component of this profile (and especially the youngest) will be students in tertiary education, themselves a potential *ebbing and flowing* driver of housing demand, the broadness of this grouping indicates another feature.

As Table 15 demonstrates Sydney experienced a massive decline in the levels of household movement from 1971 through to 2006. This trend appears to have reversed in 2006-2011, although of note it has not returned to levels seen previously. The reason for this return of household movement is squarely placed as a facet of the returning presence of the younger demographic seen in Figure 25. However, this rebound in the levels of movement is not universal, and as can be seen in Tables 16 through 18, different locations have either regained strongly (to levels not seen since 1991-1996), regained weakly (levels of mobility increasing from 2001-2006 to 2006-11, but not to the volumes seen in 1991-96) or continued to lose connectivity. Largely the locations regaining connectivity within the city are both those that have experienced the majority of higher density development *and* become the origin to many of the outflows identified in this research – specifically those where Couple Families with Children are expressing demand for attached housing. The general reading of Sydney's Housing Market's performance over the last couple of years can therefore be seen as one that is beginning to be rejuvenated – although the caveat to this finding is the limiting factor of affordable housing stock to capitalise on the growing demand coming from households at the mid-point of their housing career pathways'.

Table 15: Changing rates of mobility 1971-2011

	1971-1976	1991-1996	1996-2001	2001-2006	2006-2011
Persons moving between LGA (Gross rate per 1000)	172	165	162	140	160

Table 16: LGAs strongly regaining connectivity

LGA	Rates Per 1000 (1991-1996)	Rates Per 1000 (1996-2001)	Rates Per 1000 (2001-2006)	Rates Per 1000 (2006-2011)
North Sydney	257	246	240	327
Sydney	222	205	172	284
Marrickville	204	202	208	266
Strathfield	188	184	185	246
Canada Bay	189	213	203	242
Botany Bay	158	158	159	208
Auburn	137	134	137	179
Ku-ring-gai	128	142	127	170
Woollahra	190	172	168	230
Leichhardt	233	225	223	271
Randwick	144	134	126	173
Ashfield	213	196	179	238
Parramatta	190	181	168	215
Holroyd	168	171	159	191
Waverley	186	158	144	209
Burwood	197	179	153	217
Ryde	173	177	152	189
Hunter's Hill	239	250	215	255
Lane Cove	230	220	204	245
Rockdale	170	161	152	182
Willoughby	212	215	199	223
Hurstville	177	187	157	187
Mosman	222	209	182	231
Kogarah	202	194	184	209
Canterbury	151	134	124	150
Manly	213	181	166	211

Table 17: LGAs weakly regaining connectivity

LGA	Rates Per 1000 (1991-1996)	Rates Per 1000 (1996-2001)	Rates Per 1000 (2001-2006)	Rates Per 1000 (2006-2011)
Fairfield	81	82	64	76
Bankstown	138	139	112	131
Hornsby	165	166	145	151
Sutherland Shire	104	98	77	83
Blacktown	151	144	121	130
Gosford	137	122	86	108
Penrith	142	133	107	110
Campbelltown	137	121	97	102
Hawkesbury	187	164	125	137
Liverpool	227	226	129	135

Table 18: LGAs continuing to lose connectivity

LGA	Rates Per 1000 (1991-1996)	Rates Per 1000 (1996-2001)	Rates Per 1000 (2001-2006)	Rates Per 1000 (2006-2011)
Baulkham Hills	172	220	198	174
Blue Mountains	140	150	124	124
Wollondilly	186	199	182	170
Warringah/Pittwater	160	161	149	141
Wyong	175	172	132	114
Camden	323	317	219	210

Technical Report Conclusions and next steps

This technical paper has set out to explore and visualise the main housing market dynamics in operation across Sydney. The basis for this research is grounded within the application of a housing market framework as both a means from which to identify areas for analysis and as a mechanism with which to contextualise findings.

Realistically, if you want to understand local demand one of the best ways to undertake this is to consider what current demand looks like and where it came from. By looking in the areas where demand came from to see if similar profiles exist (or are developing) provides a logical approach for the undertaking of such analysis. However, such a task whilst sounding simple can be fiendishly complex to conduct systemically. By placing emphasis on the linkages a location has within the city and by characterising these linkages, as has been attempted in this research, offers such an approach. However, it is important to note that the data and process used to create the boundaries for analysis relate to one specific point in time. Given the changing nature of housing demand that has been seen throughout the analytical section it is perhaps pertinent to question whether these processes themselves can reshape Housing Market Demand Areas?

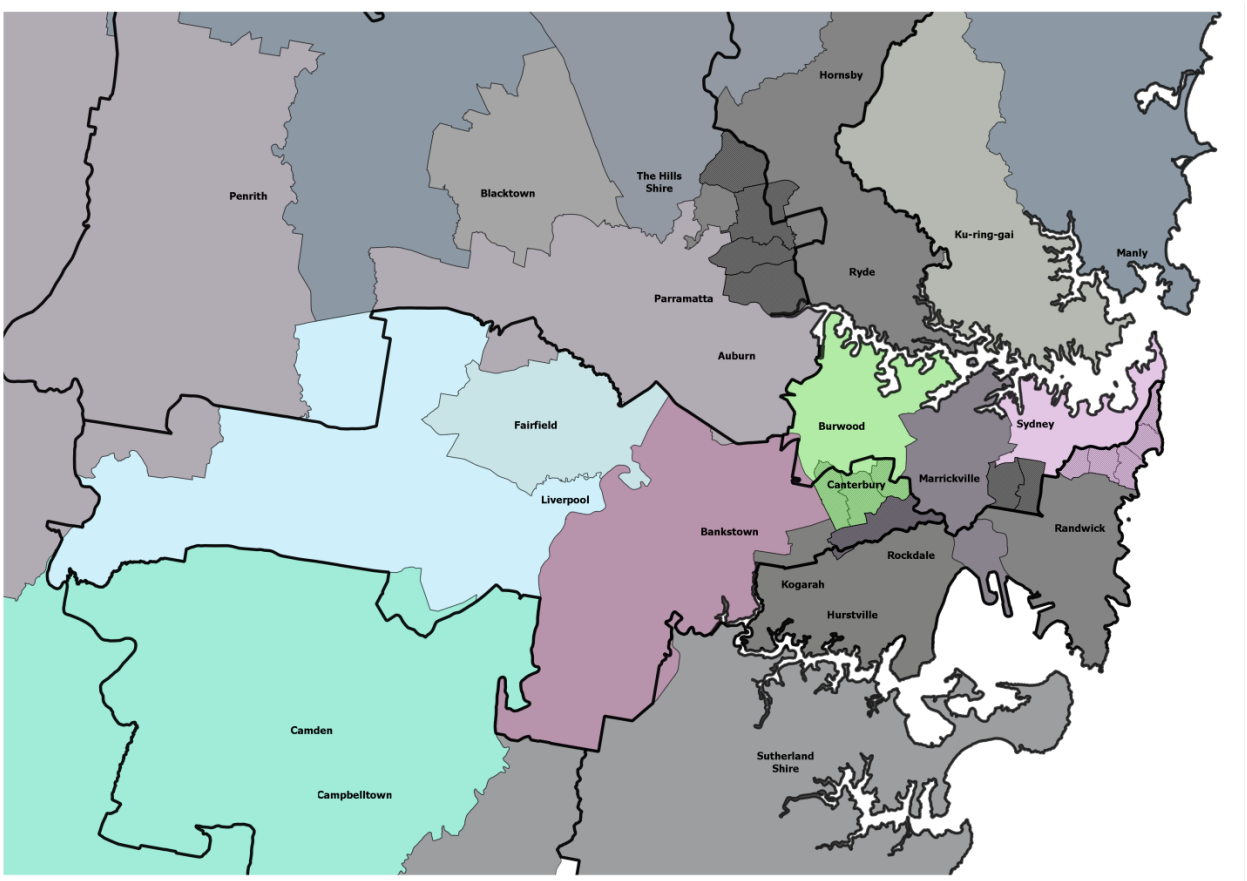
With the release of the 2011 Census it became possible to consider mobility containment at a substantially greater level of spatial resolution then previously. For example, the 2006 boundaries were constructed using the old SLA geography comprising ~30-50,000 persons, the new SA2 unit (the lowest spatial scale at which mobility data is available) decreases this to ~15-20,000. This improvement in resolution offers the ability to observe whether levels of containment observed at the higher order SLA geography may actually be collections of more local level HMDA structures. Given the spatial size of the 2006 HMDA geography, and given that we know that, on average, 70% of moves are within a 15 kilometre radius of the households origin further raises the possibility that the 2006 HMDA geographies may well be masking more local level structures. There is, however, one limitation to this test namely the differences in time periods under observation. This might mean that some variances between the 2006 and 2011 HMDAs are due to changes within patterns of mobility occurring over the inter-censual period. Unfortunately, this effect cannot be directly tested, although it can be contextualised through observing the origin and destinations of main flows shaping these alterations. Obtaining a better understanding of the profile of these altering flows, essentially patterns of mobility reshaping housing demand, could offer the ability to consider changing demand in spatial context.

On the whole the 2011 boundaries *did* nest within the larger 2006 boundaries (**Figure 26**). Essentially this confirms the first observation that the structures of demand operating within Sydney were much more localised in nature then the groupings of SLAs could identify. Eastern Sydney (2006) splits into two regions north and south of the Georges River and thus identifies Sutherland as a discrete market area in its own right. In Western Sydney (2006) three regions are identified; an area broadly conterminous to the

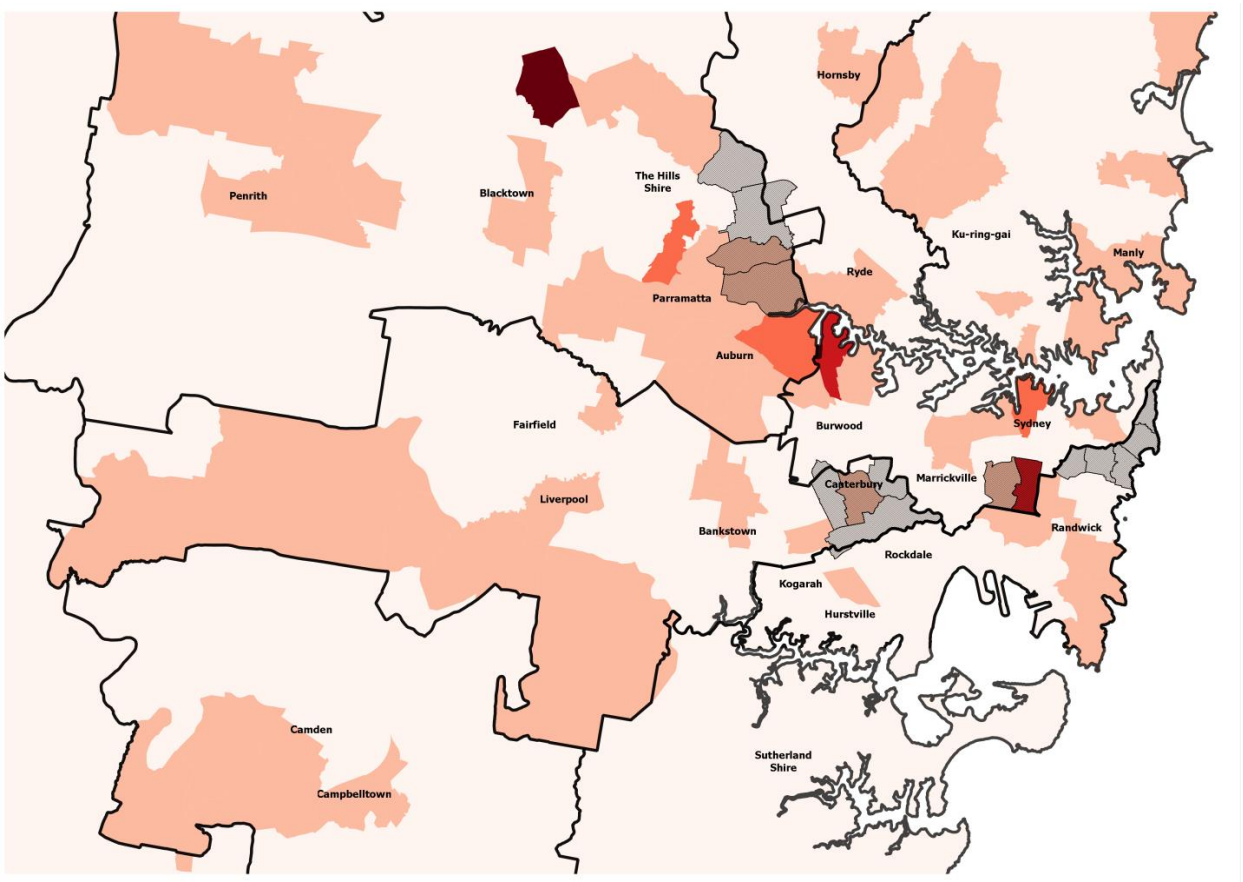
older fibro belt and Central Bankstown, a fringe location stretching west of Liverpool and a highly self-contained area around Fairfield. Parramatta and North West (2006) is split five ways. Auburn joins Central Parramatta (an effect seen in the previous iteration at the SLA level), Blacktown and The Hills Shire locations are separated by the Windsor Road, Penrith joins a larger area orientated towards the Blue Mountains and is separated from the 2006 grouping by a more rural structure orientated around Richmond. North Sydney and Shore (2006) is neatly split between the North Sydney, Ku-ring-gai, Hornsby axis and one running from Manly up to Mona Vale. This set of disaggregation is logical and essentially present a more accurate picture of demand structures which were previously masked.

There are four locations (marked as hatched on **Figure 26**) which suggest a level of deviation from the 2006 position. Five SA2s, running in a line from Ermington in the south to West Pennant Hills in the north, have associated with demand flows at work in Central Northern Sydney. A grouping comprising four SA2s around Canterbury, Belmore and Kingsgrove have become orientated more towards demand stemming from the Inner West whereas previously they operated within Western Sydney. Development around Alexandria and Waterloo appears to have orientated these locations towards pressures coming out of Eastern Sydney. Finally, a band running from Centennial Park through to Dover Heights, previously associated with Eastern Sydney has become more aligned towards the Inner City.

Figure 26: Comparison of 2006 HMDA to 2011 HMDA



It is pertinent to consider whether these changes to the underlying demand structures are generally related to the presence of new supply. Increasing provision can, of course engender new moves into an area and thus potentially serve to reshape a location's relationship with the wider city**. Figure 27** maps out key concentrations of new property development (derived from the Census Time Series) running light through to dark red. Overlaying this are the groupings of SA2s that deviated from their 2006 HMDA. As can be seen above only Erskineville-Alexandria has contained marked increases in overall numbers of households between 2006 and 2011. This finding raises an interesting question concerning a tension between the roles new supply plays in shaping underlying housing market function. Put simply, should we always expect that new supply *fundamentally* and *always* reshapes a local housing markets relationship to the wider city? This wouldn't seem to be the case, and indeed may of the locations witnessing much greater supply increases remain fixed within their pre-existing demand generated geographies.



Appendix 1: Validation of RPI variable

This appendix sets out a piece of analysis to support the use of the RPI variable as a means to generate information on household movement. The ABS describes the RPI as:

The Family/Household Reference Person Indicator (RPI) identifies the household member used in Census coding as the starting point for identifying the relationships between usual residents of a household. Familial relationships are defined in terms of the relationship between the family reference person and all other family members.

This variable has limited statistical value but is included for use in population and dwelling projection models.

On the Census form, people are asked to state their relationship to Person 1. If suitable, Person 1 will then be used as the basis for coding family and relationship details. If Person 1 is not the most appropriate reference person, coders assign a reference person based on age, marital status and relationship considerations. A reference person must be a usual resident of the dwelling aged 15 years and over, and also present on Census Night i.e. not temporarily absent.
In multiple family households, there is a reference person for each family. The reference person for the primary family is usually defined as the household reference person. The identification of a family reference person allows each family within a dwelling to be treated as a separate entity for tabulation purposes.

For group households, the first person on the form who meets the above criteria will become the reference person. For visitor only households and households with no person present aged 15 years and over, the household is considered 'non-classifiable' and no reference person is assigned.
Questionnaire testing conducted by the ABS has found no better method of identifying relationships in a household than seeking 'relationship to Person 1'. (2901.0 - Census Dictionary, 2011)

Essentially, the RPI needs to be a person over the age of 15 who is a permanent resident within the household. To initially assess the validity of the RPI variable **Table A1** considers the position of this person within each household or family. Well over 95% of the RPI's are classifiable as a person who would have had an active influence in the household's decision to move (partner, spouse, lone parent or lone person).

Table A1: Validating the RPI as a person with an active role in making household decisions

RPI Family/Household Reference Person Indicator	Single Family	Two Family	Three Family	Non-Family
Husband, Wife in a registered marriage	72.0%	73.9%	77.2%	0.0%
Partner in de facto marriage, opposite-sex couple	9.7%	6.1%	5.8%	-
Partner in de facto marriage, male same-sex couple	0.5%	0.1%	-	-
Partner in de facto marriage, female same-sex couple	0.3%	0.1%	-	-
Lone parent	15.5%	19.9%	17.0%	-
Brother/sister	1.5%	-	-	-
Father/mother	-	-	-	-
Non-dependent grandchild	0.0%	-	-	-
Grandfather/grandmother	0.2%	-	-	-
Cousin	0.1%	-	-	-
Uncle/aunt	0.1%	-	-	-
Nephew/niece	0.0%	-	-	-
Other related individual	0.1%	-	-	-
Unrelated individual living in family household	-	-	-	-
Group household member	-	-	-	13.7%
Lone person	-	-	-	86.3%
Total	100.0%	100.0%	100.0%	100.0%

To further test the validity of the RPI variable the following compares overall counts of households derived using the RPI methodology against the total count of all moving households in Sydney (2011 figures).

A headline (for the Sydney Greater Capital City Statistical Area) count of RPI's who had moved in the 5 year period (previous location either elsewhere in Australia, so counting both moves to Sydney and within Sydney and RPI moving from Overseas) gives a total of 602,341.

To validate this count **Table A2** has been generated using the MV5D variable in the Family count data set. This provides a total figure of 599,879 for households moving location in totality (top line) and 125,631 for partial moves (second line). In total this is 725,510, which is greatly in excess of the value generated by the RPI method.

Table A2: Family-Household counts

MV5D	One family household	Multiple family household	Non-family household	Non-classifiable	Total
All residents aged five years and over changed address during the last five years	421,246	20,772	157,861	0	**599,879**
Some residents aged five years and over changed address over last five years but all stated address five years ago	83,948	31,093	10,590	0	**125,631**
No residents aged five years and over changed address over the last five years	619,331	25,411	224,757	0	**869,499**
Not stated	30,283	4,499	15,555	0	**50,337**
Not applicable	0	0	0	80,135	**80,135**
Total Household Type	**1,154,808**	**81,775**	**408,763**	**80,135**	**1,725,481**

Further to this 927,711 RPI's reported the same address in 2011 as 2006, but the count generated from the MV5D is 869,499 (third line), so the RPI methodology would appear to be generating an undercount of movement and an over count of stayers, but as the calculation below demonstrates, this can be resolved:

Count of all one family households = 1,154,808

Count of RPIs one family households= 1,154,808

Count of "Not Applicable" persons under the family count = 575,648

Count of RPI's not in Family households = 408,763

Count of Lone Person Households + Count of Group Households = 408,762

The difference being the 166,885 people in group households (less the 2719 non-family persons in non-private dwellings)

Therefore, what the RPI methodology cannot assess is the origin and destination patterns of persons moving into an existing house where another individual is identified as the RPI. The methodology, therefore, misses out on the dynamics of persons moving into Group Houses or a parent or grandparent moving into a family home, or the return of an adult child (conversely, though, the flow of adult children *leaving* the family home will be captured by the methodology). Realistically, and for the purposes of profiling total *housing* demand (rather than total demand expressed for housing), this isn't too great a limitation as the denominator used is the aggregate count of private residential dwellings.

Validating RPI income as indicator of Household Income

Since individual incomes may vary from Household Incomes (for example a partner or spouse of the RPI might have considerably higher or lower earning capacity) a validation of this in relationship to Household

income is necessary; essentially do Individual incomes reported by the RPI increase in line with Household incomes and are Individual incomes a relatively sound proxy for Household Incomes?

Using the Persons Location on Census night (that is *where* the RPI was living on Census night) it is possible to compare the distribution of Individual Incomes to reported Household incomes. A summary of this is provided in **Table A3**, with Individual Incomes as columns and Household Incomes as rows.

Table A3: Comparison of RPI Individual Incomes to Household Incomes

	Negative income	Nil income	$1-$10,399	$10,400-$15,599	$15,600-$20,799	$20,800-$31,199	$31,200-$41,599	$41,600-$51,999	$52,000-$64,999	$65,000-$77,999	$78,000-$103,999	$104,000 or more
Negative Income	63%	1%	0%	0%	0%	0%	-	-	-	-	-	-
Nil Income	-	39%	-	-	-	-	-	-	-	-	-	-
$1-$10,399	3%	3%	40%	0%	0%	0%	-	-	-	-	-	-
$10,400-$15,599	3%	2%	2%	27%	0%	0%	0%	-	-	-	-	-
$15,600-$20,799	4%	2%	3%	2%	53%	0%	0%	0%	-	-	-	-
$20,800-$31,199	5%	5%	9%	37%	2%	43%	0%	0%	-	-	-	-
$31,200-$41,599	4%	6%	8%	10%	21%	5%	39%	0%	0%	-	-	-
$41,600-$51,999	1%	6%	7%	5%	5%	22%	5%	37%	0%	0%	-	-
$52,000-$64,999	4%	7%	7%	6%	7%	7%	12%	9%	36%	0%	-	-
$65,000-$77,999	3%	6%	6%	4%	3%	6%	16%	8%	8%	36%	0%	-
$78,000-$103,999	4%	8%	8%	5%	4%	8%	13%	23%	16%	15%	38%	-
$104,000-$129,999	4%	3%	2%	2%	2%	4%	8%	13%	25%	22%	18%	0%
$130,000-$155,999	1%	10%	7%	2%	1%	1%	2%	6%	7%	13%	15%	41%
$156,000-$181,999	0%	1%	1%	1%	0%	2%	3%	3%	2%	8%	19%	18%
$182,000-$207,999	0%	1%	0%	0%	0%	0%	1%	1%	4%	5%	3%	13%
$208,000-$259,999	0%	0%	0%	0%	0%	0%	0%	1%	1%	2%	7%	11%
$260,000 or more	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	17%

The values presented as column percentages, so 63% of RPIs reporting Negative Incomes were living in households also reporting negative incomes. After this, there is a relatively long “tail” in the household income distribution for Negative Income RPIs, although importantly, 88% of these persons lived in Households with an income under $65,000 (just above the actual median household income in Australia of $64,168). A similar distribution can be seen in the Nil Income category with 71% of Nil Income RPIs in households earning below the median. The 10% of Nil Income earning RPIs in high earning households almost certainly represent persons out of work (or out of the Labour Force entirely) but with a high income earning partner or spouse. For the very low income RPIs (<$10,399), again, over three-quarters lived in Households reporting below median incomes.

After these an obvious pattern sets in reflecting a broadly linear relationship between RPI and Household Income, although at the top end this begins to bunch up. This effect is probably due to the smaller number of individual income bands then Household income bands. However, what this does demonstrate is that an Individual RPI's reported income is a relatively sound proxy for general Household Income. It enables the profiling of household movement patterns to be broadly represented as low, medium or high based purely on the reported income of the RPI.

Appendix 2: Joining Points

Much of the analysis presented in this report has been facilitated through connecting the centroids (points in the geographical centre) of SA2s. Doing so enables access to a large volume of previously unseen information on the relationship between origin and destination. Whilst such information has been routinely collected through resources, such as the Census, for a considerable period of time the analytical power it retains has been relatively of niche interest, until recently[5]. The main reasons for this have been (until *very* recently) technical and representational. As Rae (2011) discusses the conceptual basis for mobility mapping have been hampered by *"…*[a] *relation to the representation and understanding of flow data*" (p.777). To this the research can add the point of *replicability*, essentially whether the data, tools and processes needed to replicate or extend the analysis are generally available.

In the most general terms this final stage of *replicability* has been reached. As discussed, data is widely available, points can be joined, hardware to conduct such joins is readily available (the analysis conducted in this report was carried out on an $800 laptop, rather than mainframe environments needed previously) and software which allows intuitive representations of the information are accessible under GNU General Public License. Put simply, joining points has never been achievable.

This said, in the initial stages of the analysis points were joined together to form the basis of the flow maps used the *createline* command executed in the MapBasic window of MapInfo. The *createline* command is a legacy SQL statement, using an extension of Standard Query Language as a wrapper to simplify the C-like core programming language of MapInfo (essentially, this means that the researcher doesn't have to get involved with the programming language behind this statement).

A similar process can be deployed in version 9.3 (and later) of ArcGIS using the *Create attributed lines from points* ArcScript (http://arcscripts.esri.com/details.asp?dbid=15828). The resulting joined file types can also be imported into the QGIS package, and this was utilised for the majority of the maps created in this report; mainly due to the superior image processing this package allows.

Using either process creates a polyline layer with the attributes of the original point layer. These attributes can then be utilised within GIS packages to perform both standard or spatial queries and updates. Standard queries that can be deployed are the selection of specific flows within the overall data set; those sharing a common profile (for example, persons aged 25 to 35) or sharing similar origins and destinations. Spatial updates to the resulting files can be included in the attribution of origin and

[5] As an interesting aside, one of the earliest examples of mobility mapping as the basis for housing analysis was conducted in Australia. Chris Maher (Maher, 1984: ABS Cat: 3410.0), with access to in-house ABS resources produced probably the first systemic mobility based analysis of neighbourhood utilisation and housing demand. That this research remains relatively obscure is more to do with the technical difficulties in replicating such analysis then to do with its utility for planning.

destination information (such as HMDA or HMSA) and the identification of flows crossing over, or intersecting, different boundary groupings and the attribution of the length of the flow. The later of these is especially useful when attempting to identify the profile of local demand (those stemming from within 15km, for example) against longer distance moves.

Both GIS formats utilise a standard flat file (dbase or excel format) to handle the interlinked locations. Such files can be imported into Excel for graphing purposes and further exploration. They can also be readily exported into statistical packages (SPSS was utilised for this linkage), thus enabling Cluster or Principle Components Analysis to be conducted on the constituent profiles of the flows. The resulting groupings from such analysis can be imported back into the GIS package for subsequent visualisation, or indeed further spatial analysis.

Finally, turning to the main GNU package used for the presentation of the analysis, QGIS, there are a number of bespoke packages that can be accessed to perform Flow map like analysis. However, many of these limit the extraction of the linked information. The following Python based code was utilised to replicate the *createline* MapInfo command[6]:

```
vl = QgsVectorLayer("LineString", "lines", "memory")
vl.startEditing()
dp = vl.dataProvider()
layer = QgsMapLayerRegistry.instance().mapLayersByName("points")[0]
dp.addAttributes(layer.pendingFields())
for feature in layer.getFeatures():
    x1, y1, x2, y2 = (feature["x1"].toFloat()[0],
                      feature["y1"].toFloat()[0],
                      feature["x2"].toFloat()[0],
                      feature["y2"].toFloat()[0])

    f = QgsFeature(layer.pendingFields())
    line = QgsGeometry.fromPolyline([QgsPoint(x1,y1), QgsPoint(x2,y2)])
    f.setGeometry(line)
    f.setAttributes(feature.attributes())
    vl.addFeature(f)
vl.commitChanges()
QgsMapLayerRegistry.instance().addMapLayer(vl)
```

This command creates a new file of lines connecting points with attributed values (scale). Importantly, it retains the origin and destination points as a separate file (other flow approaches combine these). Retaining the origin and destination points is useful as it enables the impact of the leaving and arriving profiles to be assessed in place as well as along the lines that connect them. Place and connectivity are therefore treated as two discrete spatial interactions. Methodologically, this is an important distinction to

[6] The basis of this code was suggested by Nathan Woodrow, a regular contributor on the GIS StackExchange website: http://gis.stackexchange.com/questions/56932/how-to-write-an-equivalent-to-mapbasics-createline-in-pyqgis

make. Flows connecting locations can be analysed separately – for example in order to understand whether the connections are changing in profile. Similarly locations can be assessed separately in order to gain an understanding as to whether profiles of leavers and stayers are similar or different to the population at large.

Appendix 3: Percentage profile of movers by age-income

Table A4) sets out the percentage profile of each age-income mover within their HMDA of destination. Each column has been colour coded blue (low presence of specific age-income cohort) through to red (greatest presence). Essentially, this presents a heat map of key demographic cohorts expressing demand within each HMDA. The general patterns observed in **Figures 12** through **19** can be observed and comparisons can be drawn between the different (and similar) operational fundamentals at work in each HMDA.

Some of the more striking features which become obvious through this presentation approach are:

- The younger (and lower income) age cohorts operating in Parramatta and North West, Rural Fringe, South West Sydney and Western Sydney HMDAs and the continued *gradual* upward transition of these (in income terms) through the 30-34, 35-39 and 40-44 age groupings;
- The clustering of moderately high income younger households in the City and Harbour Side and Eastern Sydney HMDA, and the *rapid* upward transition of incomes within the 30-34 age cohort. The point being made here is that this transition might, in part, not be driven by transitions through the labour market but instead be due to a different population arriving in these HMDAs;
- The high income spikes in the North Sydney (and Shore) HMDA are evidentially the main feature driving demand in this location;
- Central Northern Sydney HMDA presents a much broader profile of demand, essentially smoothed out across many of the age-income groupings.

	Percentage of overall demand by HMDA							
	Central Northern Sydney	City and Harbour Side	Eastern Sydney	North Sydney (and Shore)	Parramatta and North West	Rural Fringe	South West Sydney	Western Sydney
Low Income (15-19)	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
High Income (15-19)	0%	0%	0%	0%	0%	0%	0%	0%
Low Income (20-24)	0%	1%	0%	0%	0%	0%	0%	0%
	0%	1%	0%	0%	1%	1%	0%	1%
	0%	1%	1%	0%	1%	1%	0%	1%
	1%	1%	1%	0%	1%	1%	1%	1%
	1%	1%	1%	1%	1%	2%	1%	1%
	1%	1%	1%	1%	1%	1%	1%	1%
	1%	1%	1%	1%	1%	1%	1%	0%
	0%	1%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
High Income (20-24)	0%	0%	0%	0%	0%	0%	0%	0%
Low Income (25-29)	0%	0%	0%	0%	1%	1%	1%	1%
	0%	1%	1%	0%	1%	1%	1%	1%
	0%	1%	1%	0%	1%	1%	1%	1%
	2%	2%	2%	1%	2%	2%	2%	2%
	2%	2%	2%	1%	3%	2%	2%	3%
	2%	3%	3%	2%	3%	2%	3%	2%
	2%	3%	3%	2%	3%	2%	3%	2%
	2%	3%	2%	2%	2%	1%	2%	1%
	1%	3%	2%	3%	2%	1%	1%	1%
High Income (25-29)	1%	2%	1%	2%	1%	0%	1%	0%
Low Income (30-34)	1%	0%	0%	0%	1%	1%	0%	1%
	1%	0%	0%	0%	1%	1%	1%	1%
	1%	1%	1%	0%	1%	1%	1%	1%
	1%	1%	1%	1%	2%	2%	2%	2%

	2%	2%	2%	1%	3%	2%	2%	3%
	2%	2%	2%	1%	3%	2%	2%	3%
	2%	3%	3%	2%	3%	2%	3%	2%
	2%	3%	3%	2%	3%	2%	2%	2%
	3%	4%	4%	4%	3%	2%	2%	2%
High Income (30-34)	3%	6%	4%	6%	2%	1%	1%	1%
Low Income (35-39)	1%	0%	1%	0%	0%	1%	1%	1%
	1%	0%	0%	0%	1%	1%	1%	1%
	1%	0%	0%	0%	1%	1%	1%	1%
	1%	1%	1%	1%	1%	2%	2%	2%
	2%	1%	2%	1%	2%	2%	2%	2%
	1%	1%	2%	1%		2%	2%	2%
	2%	2%	2%	2%	2%	2%	2%	2%
	2%	2%	2%	2%	2%	2%	2%	2%
	3%	3%	3%	3%	3%	2%	2%	2%
High Income (35-39)	4%	6%	4%	8%	2%	1%	1%	1%
Low Income (40-44)	0%	0%	0%	0%	0%	0%	0%	0%
	1%	0%	0%	0%	1%	1%	1%	1%
	1%	0%	0%	0%	1%	1%	1%	1%
	1%	1%	1%	1%	1%	2%	1%	2%
	1%	1%	1%	1%	2%	2%	2%	2%
	1%	1%	1%	1%	2%	1%	2%	2%
	2%	1%	2%	1%	2%	2%	2%	1%
	1%	1%	1%	1%	1%	1%	1%	1%
	2%	2%	2%	2%	2%	2%	2%	1%
High Income (40-44)	3%	4%	3%	7%	2%	1%	1%	1%
Low Income (45-49)	0%	0%	0%	0%	0%	0%	0%	0%
	1%	0%	0%	0%	1%	1%	1%	1%
	1%	0%	0%	0%	1%	1%	1%	1%
	1%	0%	1%	1%	1%	1%	1%	2%
	1%	1%	1%	1%	1%	2%	2%	2%
	1%	1%	1%	1%	1%	1%	1%	1%
	1%	1%	1%	1%	1%	1%	1%	1%
	1%	1%	1%	1%	1%	1%	1%	1%
	1%	1%	1%	1%	1%	1%	1%	1%
High Income (45-49)	2%	2%	2%	5%	1%	1%	1%	0%
Low Income (50-54)	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	1%	1%	0%	1%

	1%	0%	0%	0%	0%	1%	1%	1%
	1%	0%	1%	0%	1%	1%	1%	1%
	1%	0%	1%	1%	1%	1%	1%	1%
	1%	0%	1%	1%	1%	1%	1%	1%
	1%	1%	1%	1%	1%	1%	1%	1%
	1%	0%	1%	1%	1%	1%	1%	0%
	1%	1%	1%	1%	1%	1%	1%	1%
High Income (50-54)	1%	2%	1%	3%	1%	1%	1%	0%
Low Income (55-59)	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	1%	1%	1%	1%
	0%	0%	0%	0%	0%	1%	1%	1%
	1%	0%	0%	0%	0%	1%	1%	1%
	1%	0%	1%	0%	1%	1%	1%	1%
	1%	0%	1%	0%	1%	1%	1%	1%
	1%	0%	1%	1%	1%	1%	1%	0%
	0%	0%	0%	0%	0%	1%	0%	0%
	1%	1%	1%	1%	0%	1%	1%	0%
High Income (55-59)	1%	1%	1%	2%	0%	0%	0%	0%
Low Income (60-64)	0%	0%	0%	0%	0%	0%	0%	0%
	1%	0%	0%	0%	1%	1%	1%	1%
	1%	0%	0%	0%	0%	1%	1%	1%
	1%	0%	0%	0%	0%	1%	0%	1%
	1%	0%	0%	0%	0%	1%	0%	0%
	0%	0%	0%	0%	0%	1%	0%	0%
	0%	0%	0%	0%	0%	1%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
High Income (60-64)	0%	1%	0%	1%	0%	0%	0%	0%
Low Income (65-69)	0%	0%	0%	0%	0%	0%	0%	0%
	1%	0%	0%	0%	0%	1%	1%	1%
	1%	0%	0%	0%	1%	2%	1%	1%
	1%	0%	0%	0%	0%	1%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
High Income (65-69)	0%	0%	0%	0%	0%	0%	0%	0%

Low Income (70-74)	0%	0%	0%	0%	0%	0%	0%	0%
	1%	0%	0%	0%	0%	1%	1%	1%
	1%	0%	0%	0%	0%	1%	1%	1%
	1%	0%	0%	0%	0%	1%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%
High Income (70-74)	0%	0%	0%	0%	0%	0%	0%	0%

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