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The Effect of Bilingual Education on Housing Price-a Case Study of Bilingual School Conversion

Kang Mo Koo[1] · Jerry Liang[1]

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Abstract

This paper presents a case study of the impact of bilingual school designation on housing price by analyzing the case of school conversion from a monolingual school to a bilingual school in Melbourne. We find that house price within the pertinent school catchment area responds positively by 7.8%–8.7%. Moreover, we find no significant response in the unit market where residents are less likely to be households with children. Analysis with substituted control groups such as the test catchments with extended surrounding areas, other bilingual school catchment areas, and school catchment areas of public schools with a similar level of academic performance confirms that bilingual education is positively capitalized in the house submarket.

Keywords Bilingual education · School catchment area · School zone · Real estate prices · House price · Unit price · School quality

JEL Code D1 · I2 · N3 · R1 · R2 · R3 · R5

Introduction

School quality is always one of the most important factors to be considered not only by parents, but also by other households and investors without children in their housing behavior (Hilber and Mayer 2009). Thus, school quality plays a significant role in housing price, and it has been receiving intensive attention of scholars in the field of urban economics. The evolving literature has been endeavoring to identify efficient

✉ Kang Mo Koo
kang.koo@deakin.edu.au

Jerry Liang
jerry.liang@deakin.edu.au

[1] Department of Finance, Faculty of Business and Law, Deakin University, 70 Elgar Road, Burwood, Victoria 3125, Australia

measurements of school quality in the research of housing price, and various dimensions of school quality have been tested in the urban economics literature. The main measurements of school quality in the literature contain three categories: (1) The *Input* aspects which include factors related to the amount of investment into the school (Edel and Sclar 1974; Sonstelie and Portney 1980; Bogart and Cromwell 1997; Rosen and Fullerton 1977); (2) *Output* aspects which include factors like students' test scores (Bayer et al. 2007; Livy 2017; Fack and Grenet 2010; Gibbons and Machin 2006; Gibbons et al. 2013); and (3) *School ranking* assessed by a third party that incorporates several ranking criteria such as input and output (Figlio and Lucas 2004; Beracha and Hardin 2017; Zheng et al. 2016). According to pedagogic theories, the true value of education lies in what learning experiences are provided and how efficiently this learning experiences can help the students (Postman 1997). The aforementioned types of measurement of school quality, which cannot directly reflect the learning experience of the students, are limited in terms of measuring the value of school quality or learning experience to the households. This study aims to provide empirical evidence as to how the change of educational model is capitalized in the real estate market through a case study of a bilingual school designation that happened in 2016. The specific aspect of the learning experience selected in this study is the change of language used for knowledge delivery in education, or the adoption of bilingual education specifically.

Bilingual education is different from ordinary foreign language education in that all or most of the core curriculum is taught in the foreign language. (Baetens Beardsmore et al. 2003). Existing education literature has found that bilingual education is more efficient than traditional second language teaching in helping students learn the foreign language and its cultural environment (García 2008). In addition, the literature of psychology finds that bilingual education is beneficial to students in many aspects of learning such as improving performance in linguistic and nonverbal tasks, enhancing working memory, strengthening learning capacity and problem-solving skills, developing the abstract or symbolic reasoning, and improving creativity and divergent thinking. (Bialystok 2006; Emmorey et al. 2008; Engle 2002; Fernandes et al. 2007; Ricciardelli 1992; Peal and Lambert 1962). These benefits of bilingual education may not be reflected in measurements of school spending, student test scores, and school ranking, but it should be recognized by the parents and capitalized into the housing value. We confirm this hypothesis by conducting a unique quasi-experiment based on a case event of converting a monolingual primary school to a bilingual primary school in Melbourne. We find that the conversion from a monolingual school to a bilingual school leads to an increase of housing price in the affected school catchment area by 7.8% to 8.7%. The increase is significant only in the house submarket, whereas the response in the unit submarket is muted. We attribute this difference to the heterogeneity of household composition between the two submarkets in Melbourne where the owners of units are likely to have no children living with them or children who are not close to the school age. When the transactions of houses in the pertinent school catchment area is compared with other bilingual school catchment areas, similar public school catchment areas, and the expanded surrounding area, the positive impact is more pronounced. Time falsification tests confirm that the positive impact on house price is a unique phenomenon witnessed only after the bilingual school designation in the related school catchment area. These findings imply that the benefits of bilingual education to

the students are capitalized into the housing value for the households, especially those that are likely to live with children.

Our findings provide the following contributions to the literature: First, we find evidence for a new dimension of school attributes that influence on housing value: the adoption of a bilingual teaching system. Thus, the existing measurements of school quality (school spending input, students' test scores and school ranking), which cannot capture all dimensions of the school attributes such as bilingual education, are limited in terms of reflecting the value of learning experience in housing value. Thus, further research is needed to investigate other dimensions of school quality in order to better understand the housing market. Secondly, previous literature does not distinguish among different types of residential properties in research of school quality or does not find discrepancies in the impact of school quality measurements on different types of residential property. This research contributes to the existing literature by proving that certain attributes of a school, such as a bilingual educational system, have different impact on different types of residential property (house and unit). The average number of Australian residents in the house submarket is 2.8, compared with 1.9 in the apartment submarket.[1] The 2011 census results also document that 35% of house residents in the inner Melbourne area live with children, while only 6.2% of residents in the unit market do. This means the households living in the house submarket are more likely to pay attention to the schooling system in the area. Thus, certain attributes of school such as a bilingual educational system provide different housing value implications for different types of households/investors. Finally, similar to Agarwal et al. (2017), which find that environmental regulation aiming to improve the air quality has an unintentional impact on the housing price through the labor market channel, we add additional empirical evidence of the unanticipated impact of government policy on the housing market. We conjecture that real estate price change was not factored in when the bilingual education was implemented, which is similar to the case of air pollution control. This paper contributes to literature by showing that, similar to Agarwal, Deng and Li (2017), government policy aimed at improving the educational system can also lead to unanticipated outcomes in the real estate market.

The next section will provide a brief introduction to bilingual schools in Melbourne. Then, we will review the literature on school quality in housing study context and in bilingual education to develop our hypothesis and methodology from the previous research. We will then exhibit the database description and test results, followed by the falsification analysis and further investigation on confounding factors. The whole paper will be concluded in the last section.

School System in Victoria, Australia

Melbourne, the capital city of the state of Victoria and the second-most-populous city in Australia, has been proud of its diversity and its status as an open city to immigrants. Since Melbourne was established in 1815, immigrants with various cultural backgrounds, skills, resources and languages have been making a huge contribution to the development of the city. Thus, Melbourne has always been open to and appreciative of the diversity of

[1] Detailed information can be found at: https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/2071.0~2016~Main%20Features~Apartment%20Living~20

culture and language of the residents and has supported instruction in languages other than English. Table 1 exhibits the number and percentage of primary and secondary students with access to the second language instruction from 2012 to 2016 in Victorian public schools. The table shows that both the number and proportion of primary students learning foreign languages has increased steadily from 2012 to 2016.

This trend indicates that the importance of learning a second language has been increasingly recognized by parents and schools. We do not observe significant change of the number and proportion of secondary students learning second language from 2012 to 2016. Students in secondary school choose subjects with the aim of optimizing their Victoria College Entrance (VCE) test score rather than developing second language command. However, it does not mean that studying a second language is not important for secondary students. Students in Victoria can select up to three foreign languages in five subjects on the VCE test. Thus, the bilingual students have an advantage on the VCE test compared to the monolingual students.

Bilingual education, which means learning the majority of subjects in a second language, is more efficient in terms of developing the second language skills of the students compared to the traditional language study, which allocates only a few hours in the curriculum to study the language as a separate subject. The Victorian State government recognizes the value of bilingual education and has been promoting the bilingual program in the primary and secondary school in Victoria. Victorian bilingual schools can choose to teach science, mathematics, arts and humanities in the subject language for a minimum of 450 min per week. Additionally, other activities at bilingual schools, such as library time, school assemblies, camps and excursions may also be conducted in the subject language (Slaughter and Hajek 2016). As of 2017, 12 schools out of 1375 primary or secondary schools in Melbourne offer a bilingual program. The second languages offered in existing bilingual schools include French, Chinese, Japanese, German, Spanish, and Vietnamese. Table 2 below provides the details of these bilingual schools.

Nevertheless, a lack of qualified teachers with high levels of proficiency in the target language hinders progress of further promotion of bilingual education in Melbourne (Molyneux 2006). Schools applying for bilingual conversion should establish timelines

Table 1 Provision of languages other than English – Government schools

Year	Primary Schools*		Secondary Schools*	Languages with highest Enrollments in VCE**	
	Students	%	Students	%	
2012	174,693	55.5	91,453	41.7	Chinese, French, Japanese, Italian
2013	202,327	62.6	91,654	41.9	Chinese, French, Japanese, German
2014	226,041	68.1	91,134	41.5	Chinese, French, Japanese, German
2015	262,556	77.0	91,760	41.5	Chinese, French, Japanese, German
2016	285,660	81.5	92,225	41.3	Chinese, French, Japanese, German

Note: This table reports the number and percentage of students learning languages other than English in primary schools and secondary schools in the state of Victoria from 2012 to 2016. It also reports the languages with highest enrollments in the Victoria College Entrance (VCE) test in Victoria from 2012 to 2016

Source: DET (Department of Education and Training Victoria) August Languages Survey*, and the VCAA (Victorian Curriculum and Assessment Authority)**

Table 2 List of bilingual schools in Melbourne

School	Language(s)	Subjects taught in second language
Abbotsford Primary School	Chinese (Mandarin)	Humanities, Mathematics and Languages
Aurora School	Auslan*	Humanities, Mathematics and Languages
Bayswater South Primary School	German	Humanities, Science, Arts and Languages
Benalla P-12 College	Indonesian	Humanities, Mathematics, Science and Languages
Brunswick South Primary School	Italian	Mathematics, Arts, Health and Physical Education, Science, and Languages
Camberwell Primary School	French	Mathematics, Science and Languages
Caulfield Primary School	Japanese	Humanities, Arts and Languages
Footscray Primary School	Vietnamese	The Humanities, Mathematics, Science, Arts and Languages
Gruyere Primary School	Japanese	Humanities, Arts and Languages
Huntingdale Primary School	Japanese	Humanities, Arts, Science and Languages
Kennington Primary School	Auslan	Humanities and Mathematics
Lalor North Primary School	Macedonian Greek	Humanities, Mathematics, Science, Arts and Languages
Richmond West Primary School	Chinese (Mandarin) Vietnamese	Humanities, Mathematics and Languages

Note: This table exhibits all the primary and secondary schools in Victoria that provide a bilingual program and the second language used. It also reports on what subjects are taught in the bilingual program in each school

*Auslan is the sign language used in Australia

regarding consultation with the community, building demand and support for the languages program, language & program choice, resourcing and staffing, and developing pertinent policies. They are also required to establish a languages committee which will govern and guide the process.[2] Due to the requirements and lack of adequate staffs, only one school, Brunswick South Primary School, was converted from a conventional monolingual school to a bilingual school with Italian education at the end of 2015 in the past twenty years. Brunswick South Primary School is located in the southeast of the Brunswick East suburb, which is known as a residential area for Italian immigrant and their descendants.[3] The Brunswick South Primary School has a long history of providing students with opportunities to study Italian as a foreign language. According to a phone interview with the Brunswick South Primary School, most of the

[2] Fuller description of the process can be found at: https://www.education.vic.gov.au/school/teachers/teachingresources/discipline/languages/manage/Pages/languagestart.aspx

[3] The main area of our study (treatment area) contains 4 postcodes: 3054, 3056, 3057, and 3068. According to the 2016 Census of Australia, the treatment area shows higher proportion of residents with Italian ancestry or born in Italy. Below is a summary table of Italian residents in the 4 postcodes and Victoria state.

Area	3054	3056	3057	3068	Victoria
From Italian Ancestry	7.7%	7.7%	9.0%	5.6%	4.5%
Born in Italy	2.3%	3.4%	4.0%	1.8%	1.2%
Speaking Italian	4.5%	5.4%	6.7%	3.1%	1.9%

teachers are Italian immigrants or their offspring, so they already had high level of proficiency in Italian before the school was converted into a bilingual primary school. Thus, the Brunswick South Primary School had solid foundation for an Italian bilingual teaching program, and the turnover of teaching staff after the conversion into the bilingual school was minor due to the high level of Italian proficiency of the existing staff. In addition to the qualification of the existing staffs, the efforts of the principal of the Brunswick South Primary School and the support of the Deputy Premier of Victoria and Minister for Education, who shared the Italian background and heritage, helped the designation happen.[4] In December 2015, the Brunswick South Primary School made an announcement of conversion to Italian bilingual school starting in 2016, and the time required to complete the transition into bilingual school was one year. This decision was not finalized until the local government approved funding to support the establishment of an Italian bilingual teaching program in December 2015. According to a phone interview with the Brunswick South Primary School, this funding is limited to be used in establishing an Italian bilingual teaching program in areas like purchasing teaching materials of various subjects in Italian and teaching staffs training. Furthermore, the proportion of newly enrolled students from an Italian background did not change significantly after the school was converted to an Italian bilingual school based on a survey of the Brunswick South Primary School. Also, we do not observe a significant change in number and proportion of local residents with an Italian background in the past few years. According to the census data, the number of residents with Italian ancestries was 2492, which accounted for 8.2% of the total population of Brunswick in 2011. This number increased slightly to 2749 in 2016, but its percentage in total population of Brunswick decreased to 7.7%.[5] Thus, Brunswick attracted more non-Italian residents than Italian descendants or immigrants from 2011 to 2016, and the proportion of non-Italian residents increases from 91.8% to 92.3%. We can therefore conclude that the desire to live near to residents with a similar Italian background is not the main reason the area of Brunswick and Brunswick South Primary School became more popular. The benefits of bilingual education should play an important role in attracting more non-Italian residents to move to the catchment area of Brunswick. More importantly, Melbourne's public schools enroll students based on catchment area system, which means that the residents living within the catchment area of the school enjoy priority enrollment. According to the survey on the Brunswick South Primary School, the number of applications for the school has increased dramatically since the designation of bilingual school from 2016 and exceeded the intake capacity. Thus, demand on housing in the catchment should have increased because of the establishment of the bilingual program and influenced the housing price of the catchment area. Concluding the above analysis, this incident of converting Brunswick South Primary School from monolingual primary school to bilingual school provides a unique and ideal sample to examine whether and how the provision of bilingual education is capitalized into the housing price.

[4] Related news article can be found at: https://ilglobo.com.au/news/33440/victorias-first-italian-bilingual-school-celebrates-a-milestone/

[5] The information regarding the statistics of residents with Italian ancestries in Brunswick is collected in the 2011 and 2016 Censuses. The detailed information can be found at: http://www.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/SSC20359

Literature Review

School Quality and Housing Price

The research of Oates (1969) was one of the earliest studies that examined the relationship between school quality and housing price by using the expenditure on the local public school to reflect the school quality. Later research improves the effectiveness of this measurement by scaling the expenditure on the number of students as the school quality (Edel and Sclar 1974; Sonstelie and Portney 1980; Kang et al. 2015; Neilson and Zimmerman 2014; Zheng and Kahn 2013). However, Martorell et al. (2016) found that not all the investment in a school can improve the students' performance and school quality. More importantly, using expenditure as the measurements of school quality to explain the housing price would lead to a biased estimation because of the strong correlation between the financial profile of local residents and the school budget (Bogart and Cromwell 1997; Rosen and Fullerton 1977). Thus, instead of the input (expenditure), more recently Black (1999) and Downes and Zabel (2002) find that the output of a school, such as test scores, is more relevant to the housing price than the input. The average test scores of schools have been widely used as the measure of school quality used to explain the housing price in the subsequent studies across the world (Bayer et al. 2007; Dhar and Ross 2012; Livy 2017; Fack and Grenet 2010; Gibbons and Machin 2006; Gibbons et al. 2013; Davidoff and Leigh 2008; La 2015).

The input (expenditure) or output (test score) reflect limited aspects of the school quality. Thus, further research tries to reduce the biases resulting from omitted variables by including more attributes related to school quality. These school attributes include distance from students' residences to the school, level of racial diversification of student cohorts, size of the school, competition from nearby private schools, and teacher salary (Brasington 1999; Downes and Zabel 2002; Kane et al. 2006; Zahirovic-Herbert and Turnbull 2008; Clapp et al. 2008; Fack and Grenet 2010; Sah et al. 2016). Besides including more school attributes, previous literature also tried other direct measurements of school quality such as the school ranking assessed by a third-party institution. For example, Figlio and Lucas (2004), and Beracha and Hardin (2017) find that the school quality measured by the U.S state-administered school ranking is capitalized into the housing price. Agarwal et al. (2016) find that the changes of school zones, especially the school zones of top ranked schools, have significant impact on the housing price. Zheng et al. (2016) and Feng and Lu (2013) argue that the residential units in the catchment area of top primary schools as ranked by the government are valued more than the units outside the catchment area. He (2017) finds the Academic Performance Index of local public school is positively correlated with housing price. However, using the third-party school grading would introduce new bias as the grading system is subject to the discretionary judgment of the grader.

Concluding the literature review, existing measurements cannot provide satisfying and comprehensive measurement of school quality in research on housing price. More importantly, according to pedagogic theory, the true value of school/education lies in what learning experience is provided to students and how efficiently this learning experience can help students to improve (Postman 1997). Thus, the existing measurements are limited in terms of measuring the pedagogic value of school quality in housing. To overcome this problem, Brasington and Haurin (2006) made the first attempt to introduce the value-

added approach, which assumes that the quality of the school should be measured by educational achievement, quantified as how much the school can help students to improve test scores. The value-added method can mitigate the bias of using test scores as a measure of educational achievement because the test score is the outcome of not only the school education but also the individual talent and family influence. However, some education achievements, such as communication capacity, language development, and intercultural skills, cannot be well reflected by test scores as the basis of value-added approach, but are critically important to the learning process. Andreyeva and Patrick (2017) and Salinas and Solé-Ollé (2018) show that students and their parents prefer flexible and innovative curriculum aiming for more diversified learning achievements for which they are willing to pay more. Ignoring or misgauging the need for diversified educational achievements would lead to a biased conclusion concerning as to how school quality affects housing price. This limitation might be why the research of Brasington and Haurin (2006) and Imberman and Lovenheim (2016) could not find that the school quality measured by test score is capitalized into housing value. To overcome this limitation, we try to focus on one typical education achievement: the cultivation of bilingual capacity through bilingual eduction.

Bilingual Education

Bilingual education refers to educating students in more than one language (Colin 2001). The students in bilingual education may have already been the speakers of more than one language or are learning an additional language which is used in education (Baker 1993). Bilingual education entails teaching subjects using the target language (the language other than home language) as the medium, which means that the teacher only uses the target language in teaching and that no translation between the target language and home language is provided. It is different from traditional foreign language education which teaches language as a subject for the purpose of learning an additional language (Baetens Beardsmore et al. 2003). Compared with foreign language teaching, bilingual education has a broader goal in that it "not only focuses on the acquisition of an additional language but also on helping students to become global and responsible citizens as they learn to function across cultures and worlds" (García 2008). Thus, bilingual education is more advanced than conventional foreign language teaching in terms of establishing and enhancing bilingual capacity, which is not only about the proficiency of a second language but also the understanding of the culture and social environment within which the language is used (García 2008).

Extensive research has documented that the bilingual capacity is critically important and beneficial to various dimensions of student development. For example, enhancing bilingual capacity can improve the ability to control attention while engaged in linguistic and nonverbal tasks (Bialystok 2006; Emmorey et al. 2008). Moreover, the enhancement of cognitive control in bilingual children appears to be sustained into adulthood (Bialystok et al. 2004). Also, literature shows that bilinguals have better working memories than monolinguals, and this relation is enhanced by the ability to control attention (Engle 2002; Fernandes et al. 2007). Furthermore, compared to monolinguals, bilinguals have stronger capacity for learning another new language (Bialystok et al. 2003), better learning strategies (Le Pichon Vorstman et al. 2009), and stronger problem-solving skills (Bialystok 2006). Additionally, enhancing bilingual

capacity can help improve abstract or symbolic reasoning, creativity, and divergent thinking (Ricciardelli 1992; Peal and Lambert 1962). Finally, bilingual education can improve literacy of students more effectively than monolingual education (Admiraal et al. 2006; Merisuo-Storm 2007; Slavin et al. 2011).

To summarize, bilingual education is superior to monolingual education in terms of helping students develop, even if the difference in outcome between the two types of education may not be reflected by test scores. Thus, we conclude that adopting bilingual education can improve education outcomes as a measure of school performance. This conclusion is supported by the research of Lao (2004) and Merisuo-Storm (2007), who argue bilingual education is valued more than monolingual education by parents and students. In addition, the research of Turnbull et al. (2018) indicates that the perception of parents toward school quality plays a significant role in valuing residential assets. Concluding the above analysis, we develop the following hypothesis.

Hypothesis: Bilingual Education Is Positively Capitalized into the Housing Value

Data and Empirical Methodology

Data

We collect transaction price from CoreLogic RP Data per property type. The transaction dataset contains transaction price, transaction date, property type, number of bedrooms, number of bathrooms, and number of parking spaces. For comparison purposes, we use only units and houses in the residential submarket. Due to the recording errors from the data provider, it is found that some observations have no information on the number of bedrooms and bathrooms. We drop those observations from the raw data and winsorize all the key variables at a 0.5% level from both ends. Since the bilingual designation was effective from January 2016, we use transaction data from 2 years prior to the designation and 1.5 years after the designation. Thus, our dataset covers the transaction history from January of 2014 to June 2017. The areas of interest include the Brunswick South Primary School catchment area, the vicinity area that uses the same postcode[6] as the catchment area, an expanded surrounding area around the Brunswick South Primary School catchment area, other existing bilingual school catchment areas, and public school catchment areas with similar level of student performance.[7] Summary statistics show the difference between the Brunswick South Primary School catchment area and the nearby area within the same postcode. A total of 316 houses were sold and 723 units were transacted in the subject catchment area while 1824 houses and 2055 units were sold in the vicinity. In general, the price level in house and unit market of school

[6] The school catchment area contains areas from postcodes 3054, 3056, 3057, and 3068.

[7] We use the NAPLAN (National Assessment Program-Literacy and Numeracy) score to sort out the schools with similar performance. NAPLAN assesses the literacy and numeracy level of students in year 3 and year 5 of all primary schools in Australia. Similar schools are found on the web page of www.myschool.edu.au, which is managed by Australian Curriculum, Assessment and Reporting Authority. Details of NAPLAN scores and comparisons can be found at https://www.myschool.edu.au/school/44505/naplan/similar/2015.

Table 3 Summary statistics

Panel I: Brunswick South Primary School Catchment Area					
House					
Variable	Obs	Mean	Std. Dev.	Min	Max
Sale Price (in '000 s)	316	1106.3	461.9	333.3	3450.0
No. of Bedrooms	316	2.6	0.7	1.0	5.0
No. of Bathrooms	316	1.3	0.5	0.5	3.0
No. of Parking Spaces	316	1.0	0.7	0.0	4.0
Unit					
Variable	Obs	Mean	Std. Dev.	Min	Max
Sale Price (in '000 s)	723	557.4	355.0	174.0	7800.0
No. of Bedrooms	723	1.2	1.0	0.0	5.0
No. of Bathrooms	723	0.8	0.7	0.0	3.0
No. of Parking Spaces	723	0.6	0.7	0.0	4.0
Panel II: Surrounding Area with Same Postcode (3054, 3056, 3057, 3068)					
House					
Variable	Obs	Mean	Std. Dev.	Min	Max
Sale Price (in '000 s)	1824	1115.9	561.1	133.6	8250.0
No. of Bedrooms	1824	2.7	0.8	1.0	5.0
No. of Bathrooms	1824	1.3	0.6	0.5	3.0
No. of Parking Spaces	1824	1.0	0.8	0.0	4.0
Unit					
Variable	Obs	Mean	Std. Dev.	Min	Max
Sale Price (in '000 s)	2055	571.4	375.6	100.0	8586.0
No. of Bedrooms	2055	1.6	0.9	0.0	5.0
No. of Bathrooms	2055	1.1	0.7	0.0	3.0
No. of Parking Spaces	2055	0.8	0.6	0.0	4.0

Note: This table provides summary statistics for house and unit transactions recorded between January 2014 and June 2017 in the Brunswick South Primary School catchment area and the vicinity area using the same postcodes of 3054, 3056, 3057 and 3068. Transactions below AU$ 100,000 are dropped from the sample. All currencies are in Australian dollar denotation

catchment area is lower than that of the vicinity area with slightly fewer or equal numbers of bedrooms, bathrooms and parking spaces (Table 3).[8]

Figure 1 shows kernel density of price level by property type. The first figure shows price distribution within the house market. The solid red line represents the Brunswick South Primary school catchment area, and the dotted line represents the nearby area using the same postcode as the catchment area. The second kernel density distribution

[8] In the unit submarket, the sample includes student housing or boarding units with studio type residence and shared bathroom. Thus, it is not unnatural to have 0 for number of bedrooms or bathrooms. In the house submarket, partial bathrooms without full bath facilities are recorded as zero in the raw data. We replaced zero for these observations with 0.5 bathrooms. Additionally, residents in the older houses use street parking, as old houses often have no separate parking spaces onsite. Thus, having zero parking space in house submarket is not unnatural.

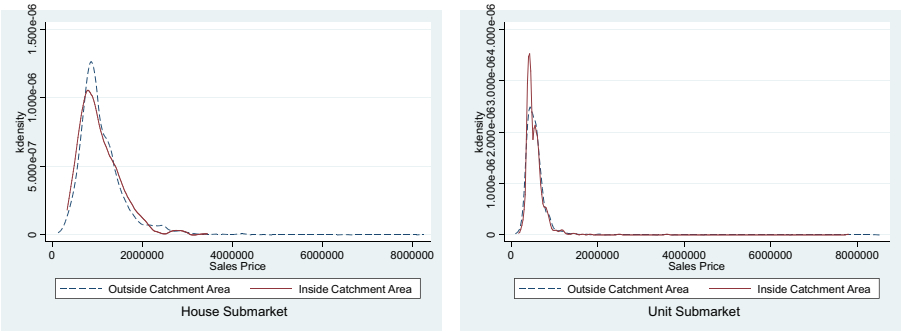

Fig. 1 Kernel density of house and unit price in the Brunswick South Primary School catchment area and the vicinity. Note: This figure reports the price distribution from the transaction data from January 2014 to June 2017 in house and unit submarkets of the Brunswick South Primary School catchment area and the vicinity area using the same postcode (3054, 3056, 3057, and 3068) as the school catchment area. The solid red line stands for the price distribution of the catchment area while the dotted line reports the price distribution of the vicinity area in both figures

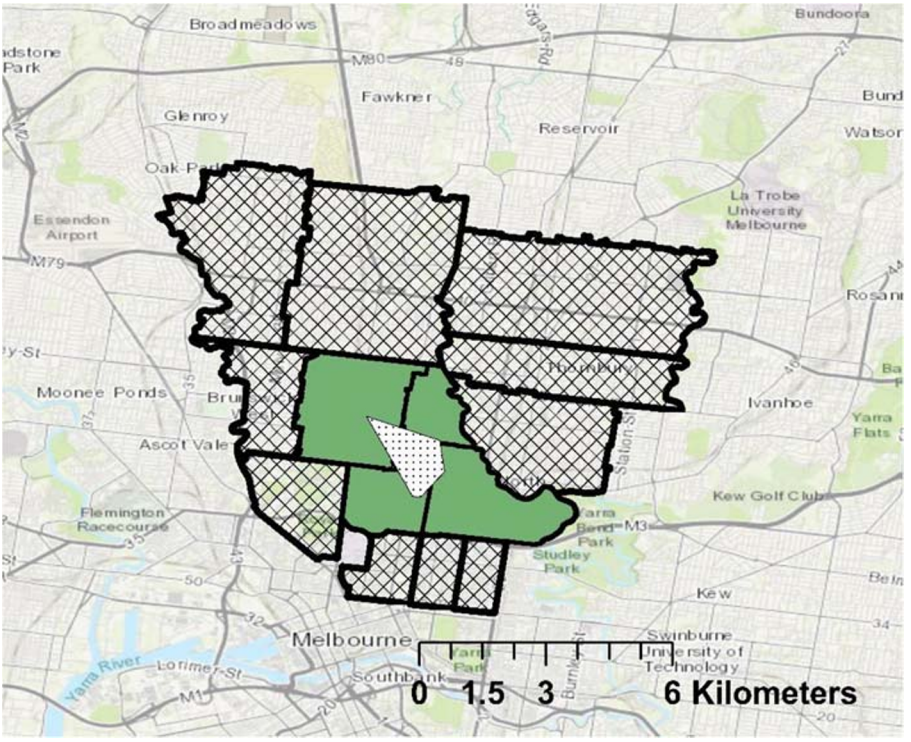

Fig. 2 Control and treatment area by postcode. Note: This figure shows the demarcation of the treatment area and control area in the analysis. The dotted area in the center is the Brunswick South Primary School catchment area. We classify the vicinity area as the area using the same postcode as the Brunswick South Primary School catchment area, and this area is colored green in the figure. The additional control area with checkered pattern includes the extended postcode area surrounding the four postcodes that comprise the Brunswick South Primary School catchment area

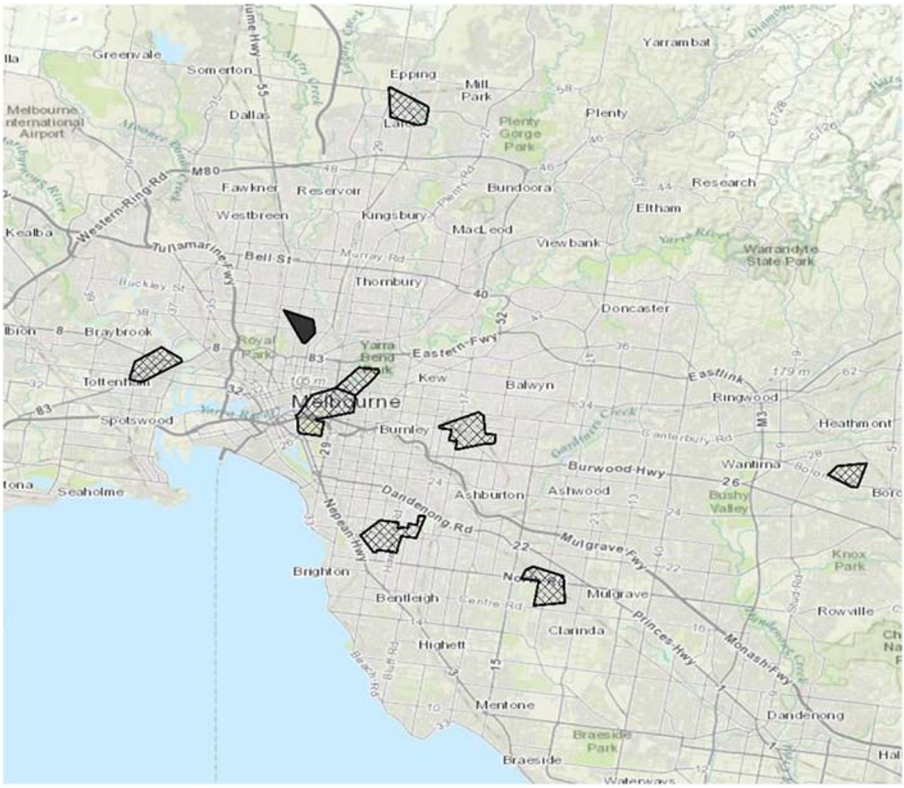

Fig. 3 Location of bilingual schools in Victoria, Australia. Note: This figure shows the location of all the bilingual schools in the state of Victoria. Out of 12 bilingual schools in Victoria, we drop 3 schools which are located over 50 km (driving distance) away from the treatment area or the bilingual education is related to sign language. The solid colored area is the Brunswick South Primary School catchment area; checkered areas are other bilingual school catchment areas

indicates the price distribution within the unit market with the same denotation as with the house market. We find that house price level in the catchment area is more dispersed than that of the vicinity area, while the unit market in the vicinity area maintains a higher concentration in the mid-price range than the catchment area.

We also use Geographic Information System (GIS) to geocode each school catchment area and the exact location of the transacted properties. Firstly, the Brunswick South Primary School catchment area is demarcated as a treatment area. Subsequently, the vicinity area and surrounding areas explained above are drawn by connecting the boundary of related postcodes. In addition to the samples described in the summary statistics, we match an additional 6090 house-transactions and 8302 unit-transactions from the expanded surrounding area Fig 2.

To consider the characteristics unrelated to the geography, two additional control groups are designed: similar public schools and other bilingual schools in Victoria. The location of each control area is shown in Fig. 3 and Fig. 4. Within other bilingual school areas, 3968 houses and 4817 units were sold during the study period. In other public school catchment areas, we find 5143 house-transaction data and 4611 unit-transaction data.

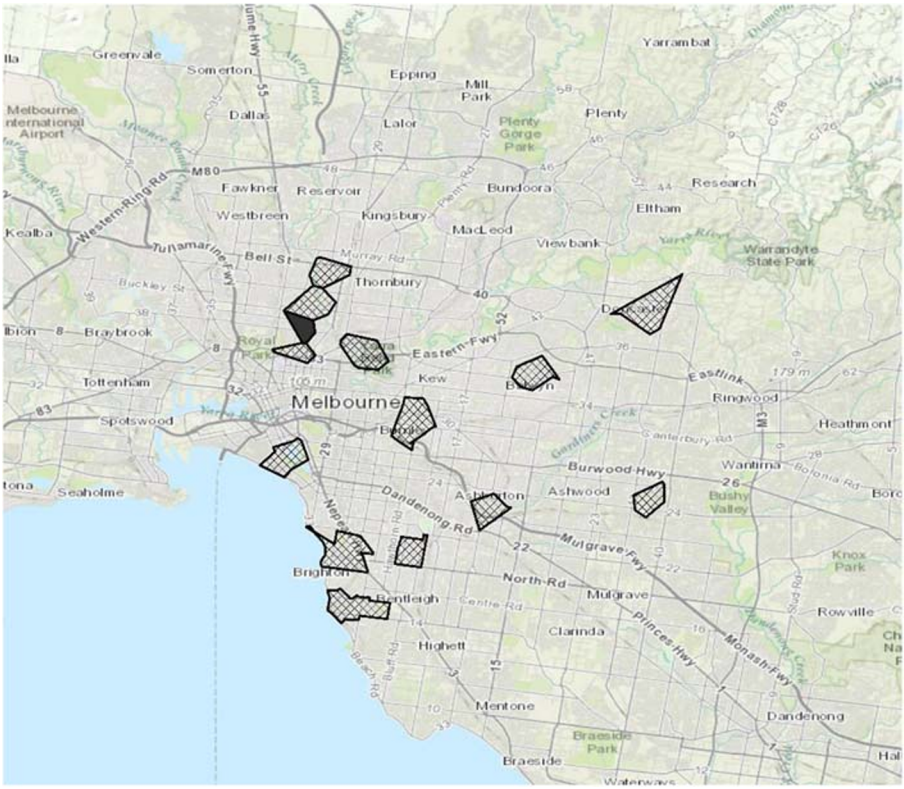

Fig. 4 Location of similar public schools and Brunswick South Primary School. Note: This figure shows the school catchment area of 13 similar public primary schools (checkered pattern) and the treatment area (grey colored). 13 similar schools are selected based on the performance of the National Assessment Program – Literacy and Numeracy (NAPLAN) from year 3 and year 5 students

Methodology

Since the public announcement of the bilingual school designation was known to the public in mid-December, we use January of 2016 as the starting point of the treatment period. We use the difference-in-difference method to capture the different market response by comparing the treatment area of Brunswick South Primary School catchment area and other control areas before and after the bilingual school designation. The time frame after the designation is classified as *After,* and the geographic area of Brunswick South Primary catchment area is named *Brunswick South Catchment*. First, we compare the Brunswick South Primary catchment area with an area in the vicinity using the same postcodes. Then, we expand the control area to the surrounding postcode area as shown in Fig. 2. The model specification of the analysis above is as follows:

$$\ln\left(Price_{i,t}\right) = \alpha + \beta_1(AfterXBrunswick\ South\ Catchment) + \beta_2(Brunswick\ South\ Catchment) + X'_{i,t}\theta + \gamma_t + \delta_{postcode} + \varepsilon_{i,t} \quad (1)$$

where β_1 is a coefficient on the interaction terms of *After* and *Brunswick South Catchment*;

X' stands for hedonic factors including number of bedrooms, bathrooms, and parking spaces; γ_t is time-fixed effect; $\delta_{postcode}$ is postcode-fixed effect; and $\varepsilon_{i,t}$ is an error term.

Next, we compare the Brunswick South Primary area with other existing bilingual schools. Lastly, other public schools with a similar level of student performance are used as control group. We add the school_name fixed-effect to the Eq. (1) as a replacement of postcode fixed-effect so that the heterogeneous characteristics of different school catchment areas can be captured. The model specification for other bilingual schools and public-monolingual schools is as follows.

$$\ln(Price_{i,t}) = \alpha + \beta_1(AfterXBrunswick\ South\ Catchment) + \beta_2(Brunswick\ South\ Catchment) + X'_{i,t}\theta + \gamma_t + \pi_{school\_name} + \varepsilon_{i,t}. \quad (2)$$

We use year and month fixed-effects separately and use the interaction of year and month-fixed effects in a separate analysis. Transaction prices are log-normalized to find the change of the price in percentage. A series of regressions are conducted based on the different classifications of the control area. When the transacted properties are located within the control area, the dummy variable *Brunswick South Catchment* is zero, while all the transactions within the Brunswick South Primary School catchment area are 1. The dummy variable of *Brunswick South Catchment* enables us to eliminate the average difference between the Brunswick South Primary School catchment area and other control area. In addition to controlling for the difference between the treatment area and the control area, including the postcode fixed-effect assures that the average difference across different postcode areas is also eliminated. If the transaction happened after January 2016, the dummy variable *After* is 1, otherwise 0. While β_2 captures time invariant differences between treatment area and control area, β_1 shows the market response after the bilingual school designation within the treatment area. As we include the time fixed-effect (γ_t), β_1 should be interpreted as the result of the difference-in-difference model. Thus, our main point of interest lies with the coefficient of β_1. We apply Eq. (1) to house submarket and unit submarket separately for the control area located close to the treatment area, while both Eq.(1) and Eq. (2) are used for the analysis of the control area from the existing bilingual school catchment area and other monolingual school catchment area with a similar level of academic performance. To avoid the issue of collinearity, postcode fixed-effects and school_name fixed-effects area used alternately. Additionally, standard errors are clustered at postcode level throughout this paper to alleviate concerns about the correlation within the same area (postcode).

Empirical Results

Table 4 reports the results from our baseline model. We compare the transaction data from the nearby area sharing the same postcode as the treatment area. The coefficient of *After X Brunswick South Catchment* is 0.078, with separate year and month fixed-effects in column (1) of Table 4. The estimated change in

Table 4 Impact of bilingual education on housing price—Vicinity area

VARIABLES	(1) ln(Price)	(2)	(3)	(4)	(5) ln(Price)	(6)	(7)	(8)
Type	House				Unit			
After X Brunswick South Catchment	0.078**	0.087**	0.078**	0.087**	−0.024	−0.023	−0.025	−0.023
	(3.61)	(3.67)	(3.22)	(3.99)	(−0.71)	(−0.64)	(−0.86)	(−0.75)
Brunswick South Catchment	−0.001	0.054**	−0.004	0.050**	0.059*	0.079**	0.062*	0.081**
	(−0.01)	(3.59)	(−0.06)	(3.18)	(2.47)	(3.68)	(2.57)	(4.11)
No. of Bedrooms	0.229***	0.211***	0.226***	0.209***	0.164***	0.163***	0.163***	0.161***
	(8.71)	(11.18)	(8.55)	(11.05)	(12.83)	(15.48)	(11.92)	(14.42)
No. of Bathrooms	0.075	0.063	0.076	0.063	0.034	0.040	0.035	0.040
	(1.46)	(1.29)	(1.46)	(1.29)	(1.44)	(1.97)	(1.49)	(2.08)
No. of Parking Spaces	0.042**	0.074***	0.045**	0.076***	−0.043	−0.053*	−0.042	−0.052*
	(3.22)	(5.84)	(3.55)	(6.25)	(−1.68)	(−2.78)	(−1.66)	(−2.84)
Constant	12.818***	13.051***	12.830***	13.049***	12.939***	13.036***	13.018***	13.129***
	(176.48)	(98.06)	(101.88)	(66.10)	(372.72)	(189.90)	(463.40)	(207.34)
Observations	2140	2140	2140	2140	2778	2778	2778	2778
R-squared	0.362	0.479	0.374	0.488	0.193	0.224	0.203	0.235
Year FE	YES	YES	NO	NO	YES	YES	NO	NO
Month FE	YES	YES	NO	NO	YES	YES	NO	NO
Year X Month FE	NO	NO	YES	YES	NO	NO	YES	YES
Postcode FE	NO	YES	NO	YES	NO	YES	NO	YES

Note: This table reports the results of regressing log-normalized house and unit price on the interaction term of dummies indicating the period after bilingual school designation and Brunswick South Primary School catchment area. A separate dummy for the Brunswick South Primary School catchment area and other hedonic factors including number of bedrooms, bathrooms and parking spaces are added in the model as specified in Eq.(1). Year fixed-effect, month fixed-effect, interaction fixed-effect of year and month and postcode fixed-effect are applied as indicated in each column. The control group is designed to include all house and unit transactions outside of the Brunswick South Primary School catchment area but located within the same postcode as the catchment area. All transactions recorded after January 2016 are classified as After since the bilingual school designation was announced in mid-December 2015. Standard errors are clustered at the postcode level. Robust T-statistics are given in parentheses. ***significant at 1%, ** 5%, * 10%

housing price is more marked when we add postcode fixed-effect in column (2). Replacing year and month fixed-effect with the interaction term of year and month fixed-effect does not make a pronounced difference in the results. This table shows that the general price level of house submarket in the treatment area is higher than in the control area.[9] However, the price suddenly increases after the designation within the treatment area. On the contrary, the response in the unit market is negative and statistically insignificant.[10] Considering the proprietors' sentiment in Australia, this is quite understandable. Households with young children prefer to live in houses with large backyard, while units are preferred by young couples without children, elderly couples or households of young adults. According to the Australian Census in Dwelling Structure by Household Composition and Family Composition from 2011,[11] it is found that couple families with children account for 35% of residents living in separate houses in inner Melbourne area whereas only 6.2% in flat, unit or apartment dwelling types contain a couple family with children. Additionally, according to the 2016 Census of Population and Housing in Australia,[12] the average number of people per apartment was 1.9 whereas the average number of people in separate house was 2.8. The figure of 1.9 in apartment indicates that average residents in apartments are less likely to have children at home. In the same report, 21% of all apartment residents in Australia were in the 25–34 age cohorts. This census finding confirms that parents with children are likely to reside in detached houses. More specifically, according to the 2016 Australian Census, only 10% of households with children from the 4 postcodes that include the Brunswick South Primary School catchment area live in either flat or apartment while 41% of households with no children or lone person live in flat or apartment. It was also reported that 12% of residents with children in the greater Melbourne area are residing in apartment or flats.[13] Since the treatment effect is expected to impact households with primary school students or younger children who are close to school age, we can infer that the significant and positive response in the house submarket is driven by the proprietors with young children.

[9] We also conducted additional analysis to see if the response is stronger in the area with higher density of Italian descendants. Postcode 3057 has the highest proportion of Italian descendants with 9% compared with 5.6%–7.7% in the other postcodes within the treatment area. When a dummy variable with postcode 3057 is interacted with the DID interaction term, the coefficient is statistically insignificant and either negative or close to zero.

[10] The coefficients of No. of Parking Space in column (5)–(8) are negative and statistically significant in column (6) and (8). This variable is generally expected to have positive impact on the property price. We recheck the dataset and find that sales agents sometimes include shared parking spaces as if these parking spaces are parts of the title. To alleviate this concern, we repeat the same regression without the variable of number of parking space and find the coefficients of interactive term *After X Brunswick South Catchment* do not change significantly.

[11] http://stat.data.abs.gov.au/Index.aspx?DataSetCode=ABS_C16_T23_SA#

[12] More detailed information can be found in the following website: https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/2071.0~2016~Main%20Features~Apartment%20Living~20

[13] This figure is from a minister's forum context report published by the Department of Environment, Land, Water and Planning of Victoria. A full report can be found at: https://www.planning.vic.gov.au/__data/assets/pdf_file/0030/9984/Better-Apartments-Ministers-Forum-Context-Report-2015.pdf

Table 5 Impact of bilingual education on housing price—Expanded area

VARIABLES	(1) ln(Price)	(2)	(3)	(4)	(5) ln(Price)	(6)	(7)	(8)
Type	House				Unit			
After X Brunswick South Catchment	0.100***	0.108***	0.100***	0.107***	0.022	0.012	0.022	0.013
	(6.03)	(4.63)	(6.45)	(4.80)	(0.64)	(0.31)	(0.65)	(0.34)
Brunswick South Catchment	0.148	0.044**	0.148	0.045**	0.128**	0.070**	0.128**	0.069**
	(1.60)	(2.62)	(1.60)	(2.66)	(3.00)	(2.98)	(2.98)	(2.90)
No. of Bedrooms	0.174***	0.182***	0.173***	0.181***	0.138***	0.144***	0.139***	0.145***
	(8.21)	(8.95)	(8.19)	(8.94)	(4.85)	(7.12)	(4.86)	(7.19)
No. of Bathrooms	0.087***	0.058***	0.088***	0.059***	0.034	0.031	0.033	0.030
	(4.04)	(4.41)	(4.15)	(4.52)	(0.73)	(0.93)	(0.72)	(0.92)
No. of Parking Spaces	−0.001	0.059***	−0.000	0.059***	0.031	0.015	0.028	0.012
	(−0.05)	(7.46)	(−0.03)	(7.64)	(0.78)	(0.63)	(0.71)	(0.52)
Constant	12.812***	12.526***	12.838***	12.549***	12.780***	12.717***	12.802***	12.738***
	(364.61)	(153.88)	(211.49)	(118.95)	(262.60)	(453.45)	(181.54)	(290.27)
Observations	8230	8230	8230	8230	11,080	11,080	11,080	11,080
R-squared	0.247	0.467	0.250	0.469	0.130	0.206	0.139	0.215
Year FE	YES	YES	NO	NO	YES	YES	NO	NO
Month FE	YES	YES	NO	NO	YES	YES	NO	NO
Year X Month FE	NO	NO	YES	YES	NO	NO	YES	YES
Postcode FE	NO	YES	NO	YES	NO	YES	NO	YES

Note: This table reports the results of regressing log-normalized house and unit price on the interaction term of dummies indicating the period after bilingual school designation and Brunswick South Primary School catchment area. A separate dummy for the Brunswick South Primary School catchment area and other hedonic factors including number of bedrooms, bathrooms and parking spaces are added in the model as specified in Eq.(1). Year fixed-effect, month fixed-effect, interaction fixed-effect of year and month and postcode fixed-effect are applied as indicated in each column. The control group is designed to include all house and unit transactions located in the surrounding postcode areas of the Brunswick South Primary School catchment area as shown in Fig. 2. All transactions recorded after January 2016 are classified as After since the bilingual school designation was announced in mid-December 2015. Standard errors are clustered at the postcode level. Robust T-statistics are given in parentheses. ***significant at 1%, ** 5%, * 10%

The price change is more marked when we expend the control area to the surrounding postcode area. The results from our regression with expanded control area is shown in Table 5. In the house submarket analysis, the transacted prices of houses are higher by 10.0% to 10.8% across different fixed-effect specifications.[14] Like Table 4, the change in unit price is muted in columns (5)–(8). Even though the residents in the catchment area should have the first priority of enrollment, residents in the close vicinity can ask for special admission consideration. Depending on circumstances and availability, the principals of schools can grant admission to students who are not living in the catchment area. However, if students live too far from the school, it would not be easy to commute from their residence to the school. We interpret the gap between the coefficients in column (1)–(4) in Table 4 and Table 5 as the difference in pricing caused by the decreasing chance of enrollment in the subject school. So, it is natural to see a higher price difference between the treatment area and expanded control area.[15]

It is also likely that the market responds to the factors that are not geographically related, such as enthusiasm among the parents for bilingual education or general school performance during the treatment time. If home buyers become more interested in bilingual education, the house price level of other bilingual school area should rise accordingly. Also, the coefficient of interest (β_1) should be insignificant when compared with control group of other bilingual schools. There are 12 other bilingual schools[16] in Victoria, and we compared other bilingual school catchment areas within a 30-km radius from the treatment area of Brunswick South Primary catchment area. The results are reported in Table 6. We find that house price in the treatment area responds positively after the bilingual school designation compared to the house price level of other bilingual school catchment areas. The house submarket has a price increase of 8.7% to 9.9% compared to the price level in other bilingual school catchment areas while the unit submarket shows insignificant and negative impact on price after the announcement.

[14] We checked the change of supply level in the four-postcode area. The number of new listings in the house submarket increased moderately, while the supply level was stable in the unit submarket. If the market was affected by the change of supply level, we suppose that it should have affected the price level negatively, which is contrary to our findings. Below is a summary of listings in each year from the four-postcode area.

	2014	2015	2016	2017
House	2664	2089	2141	2602
Unit	4051	5552	5865	5955

[15] One might suspect that using the monolingual schools surrounding the treatment area is an alternative model specification. However, in the expanded area, more than 10 monolingual schools are included. Thus, it is also found that there the price level in the treatment area had a positive change compared to other monolingual schools in the proximity of distance from the treatment area.

[16] 12 bilingual schools are: Abbotsford Primary School (Chinese), Aurora School (Auslan), Bayswater South Primary School (German), Benalla East Primary School (Indonesian), Brunswick South Primary School (Italian), Camberwell Primary School (French), Caulfield Primary School (Japanese), Footscray Primary School (Vietnamese), Gruyere Primary School (Japanese), Huntingdale Primary School (Japanese), Kennington Primary School (Auslan), Lalor North Primary School (Macedonian, Modern Greek), Richmond West Primary School (Chinese, Vietnamese). The two schools with Auslan education are not included in the control group since Auslan is Australian sign language, and Gruyere Primary School is excluded due to a remote distance from the treatment area. All the catchment areas are shown in Figure 3.

Table 6 Impact of bilingual education on housing price—Comparison with other bilingual school catchment areas

VARIABLES	(1) ln(Price)	(2)	(3)	(4)	(5) ln(Price)	(6)	(7)	(8)
Type	House				Unit			
After X Brunswick South Catchment	0.096***	0.087***	0.099***	0.090***	−0.043	−0.045	−0.044	−0.047*
	(4.42)	(5.15)	(4.44)	(4.94)	(−1.60)	(−1.67)	(−1.71)	(−1.77)
Brunswick South Catchment	0.051***	−0.003	0.051***	−0.005	0.097***	0.089***	0.096***	0.089***
	(3.18)	(−0.04)	(3.02)	(−0.07)	(3.50)	(3.42)	(3.66)	(3.40)
No. of Bedrooms	0.200***	0.211***	0.200***	0.211***	0.184***	0.190***	0.182***	0.189***
	(16.92)	(14.62)	(17.11)	(14.68)	(10.53)	(10.34)	(10.52)	(10.31)
No. of Bathrooms	0.064***	0.080***	0.063***	0.079***	0.045***	0.042***	0.045***	0.042***
	(3.19)	(3.41)	(3.21)	(3.41)	(3.68)	(2.98)	(3.82)	(3.06)
No. of Parking Spaces	0.070***	0.061***	0.071***	0.062***	0.037	0.040	0.038	0.040
	(7.25)	(4.69)	(7.31)	(4.88)	(1.06)	(1.16)	(1.06)	(1.17)
Constant	13.585***	12.469***	13.559***	12.450***	13.102***	12.623***	13.155***	12.665***
	(186.43)	(150.21)	(136.52)	(121.52)	(172.07)	(104.07)	(129.50)	(91.08)
Observations	4284	4284	4284	4284	5540	5540	5540	5540
R-squared	0.653	0.589	0.656	0.592	0.324	0.300	0.328	0.305
School_Name FE	NO	YES	NO	YES	NO	YES	NO	YES
Year FE	YES	YES	NO	NO	YES	YES	NO	NO
Month FE	YES	YES	NO	NO	YES	YES	NO	NO
Year X Month FE	NO	NO	YES	YES	NO	NO	YES	YES
Postcode FE	YES	NO	YES	NO	YES	NO	YES	NO

Note: This table reports the results of replicated regression of Table 4 with a different control area. We designate the control area as other bilingual school catchment areas in the state of Victoria. Like Tables 4 and 5, number of bedrooms, bathrooms and parking spaces are included in the model. Year fixed-effect, month fixed-effect, interaction fixed-effect of year and month, postcode, and school_name fixed-effect are applied as indicated in each column. Bilingual schools teaching Australian sign language (Auslan) or located too far from the treatment area are not included in the control group. All the transactions recorded after January 2016 are classified as After since the bilingual school designation was announced in mid-December 2015. Standard errors are clustered at postcode level. Robust T-statistics are given in parentheses. ***significant at 1%, ** 5%, * 10%

If the proprietors or investors have paid attention to the quality of education, we would see a similar trend in house price across other public school areas with a similar level of NAPLAN (National Assessment Program-Literacy and Numeracy) performance. In this case, the coefficients of interest would be close to zero or statistically indistinguishable from the price of the treatment area after the bilingual school designation. By using the NAPLAN results and analysis from a webpage managed by the Australian Curriculum Assessment and Reporting Authority, we select 13 public primary schools with similar NAPLAN performance in 2015 as shown in Fig. 4. Private schools are excluded so we may compare schools with similar facilities and systems. What we find from the analysis with other similar public schools remains almost the same as the results in the baseline results. We find positive impact on the house price by 9.5%–10.7% within the treatment area after the bilingual school designation. This result confirms that the positive impact on the house market is not from the change of investors' sentiment about the education quality. Rather, it reconfirms that the bilingual school designation plays an important role in the pricing mechanism of the real estate market.[17] Similar to previous results, the unit market does not respond. Moreover, the analysis find that unit market price dropped, albeit statistically insignificant, by 7% when *Year X Month* fixed-effect is considered in the model.

Falsification Analysis

Even though the diff-in-diff method enables us to rule out the effect from unobserved variables, one might wonder if an unknown trend has been existing in the treatment area. To answer this question, we conduct a falsification analysis with a falsified bilingual designation date. We collect transaction data from January 2008 to December 2013 and use January 2011 as a falsified starting point of treatment time. 4 regression tests are replicated with a falsified designation date following the specifications of the control area in Table 4-Table 7. In the falsification analysis of the vicinity area using the same postcode, a total of 2693 house transactions are identified, of which 2316 are located outside of the catchment area and 377 are within the treatment area, during the 6-year time period. In the same manner, the results from time falsification test with expanded surrounding area are reported from column (5) to (8). Table 8 shows that the house market in the Brunswick South Primary catchment area had almost no change in transaction price before and after January 2011. The results from falsification analysis with expanded control area are also similar. The estimated effect of falsified bilingual designation does not have any impact on the house price.

Table 9 reports the price change after the falsified designation date for the control group of other bilingual school catchment areas and similar public school catchment areas. The estimated results are negative in column (1)–(4) and statistically and economically insignificant. The level of price change in column (5)–(8) with the control group of similar public school catchment areas shows positive but insignificant

[17] Additional analysis is conducted to find the change of house price in the bilingual catchment area compared with the monolingual schools. The result finds that the price change in the other bilingual school catchment area is statistically and economically insignificant. The coefficients ranges from 0.010 to 0.017 and statistically insignificant at 10% confidence level.

Table 7 Impact of bilingual education on housing price—Comparison with other public school catchment areas

VARIABLES	(1) ln(Price)	(2)	(3)	(4)	(5) ln(Price)	(6)	(7)	(8)
Type	House				Unit			
After X Brunswick South Catchment	0.107***	0.097***	0.105***	0.095***	−0.052	−0.034	−0.070	−0.057
	(4.31)	(4.65)	(4.68)	(5.01)	(−0.76)	(−0.49)	(−1.20)	(−1.08)
Brunswick South Catchment	0.052**	−0.130	0.050*	−0.130	0.128***	0.126*	0.133***	0.135*
	(2.09)	(−1.44)	(1.99)	(−1.43)	(4.06)	(1.97)	(4.56)	(2.02)
No. of Bedrooms	0.209***	0.209***	0.208***	0.209***	0.188***	0.176***	0.188***	0.176***
	(7.09)	(7.12)	(7.17)	(7.22)	(7.68)	(6.45)	(7.65)	(6.62)
No. of Bathrooms	0.085***	0.087***	0.085***	0.088***	0.100**	0.124**	0.094**	0.114**
	(5.03)	(5.42)	(4.95)	(5.31)	(2.14)	(2.63)	(2.07)	(2.47)
No. of Parking Spaces	0.082***	0.081***	0.082***	0.081***	0.065***	0.054***	0.061***	0.051***
	(9.05)	(8.45)	(9.41)	(8.74)	(4.02)	(3.78)	(4.24)	(3.59)
Constant	12.898***	13.010***	12.883***	12.986***	12.370***	12.708***	12.357***	12.722***
	(168.80)	(116.76)	(177.50)	(122.68)	(107.48)	(139.50)	(108.97)	(148.94)
Observations	5459	5459	5459	5459	5334	5334	5334	5334
R-squared	0.643	0.626	0.646	0.629	0.512	0.488	0.528	0.511
School_Name FE	NO	YES	NO	YES	NO	YES	NO	YES
Year FE	YES	YES	NO	NO	YES	YES	NO	NO
Month FE	YES	YES	NO	NO	YES	YES	NO	NO
Year X Month FE	NO	NO	YES	YES	NO	NO	YES	YES
Postcode FE	YES	NO	YES	NO	YES	NO	YES	NO

Note: This table reports the results of replicated regression of Table 4 with other public school catchment areas as a control group. We design the control area to include other public school catchment areas with similar performance on the National Assessment Program in Literacy and Numeracy (NAPLAN) within the state of Victoria. We use the same fixed-effect specifications as Table 6. All the transactions recorded after January 2016 are classified as After since the bilingual school designation was announced in mid-December 2015. Standard errors are clustered at postcode level. Robust T-statistics are given in parentheses. ***significant at 1%, ** 5%, * 10%

Table 8 Time falsification analysis—Residence in vicinity and expanded surrounding area

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Control Area	Vicinity Area				Expanded Surrounding Area			
VARIABLES	ln(Price)				ln(Price)			
Type	House				House			
After X Brunswick South Catchment	0.007	0.017	0.019	0.027	0.009	0.026	0.015	0.032
	(0.19)	(0.49)	(0.45)	(0.71)	(0.24)	(0.84)	(0.36)	(1.02)
Brunswick South Catchment	−0.027	0.030	−0.040	0.022	0.120	0.017	0.114	0.012
	(−0.28)	(0.79)	(−0.39)	(0.53)	(1.21)	(0.51)	(1.15)	(0.35)
No. of Bedrooms	0.183***	0.178***	0.183***	0.177***	0.123***	0.139***	0.122***	0.138***
	(7.75)	(11.15)	(7.11)	(9.51)	(5.83)	(8.16)	(5.93)	(8.16)
No. of Bathrooms	0.091**	0.063**	0.092**	0.065**	0.102***	0.068***	0.103***	0.070***
	(4.33)	(4.49)	(3.90)	(4.48)	(5.56)	(7.64)	(5.75)	(7.84)
No. of Parking Spaces	0.035***	0.061***	0.034***	0.061***	0.001	0.053***	0.001	0.053***
	(5.86)	(7.30)	(13.04)	(6.57)	(0.09)	(8.52)	(0.07)	(8.57)
Constant	12.612***	12.834***	12.755***	12.953***	12.668***	12.421***	12.781***	12.508***
	(174.59)	(158.36)	(81.40)	(101.99)	(320.21)	(194.51)	(163.20)	(182.40)
Observations	2693	2693	2693	2693	9816	9816	9816	9816
R-squared	0.253	0.387	0.272	0.404	0.169	0.410	0.181	0.420
Year FE	YES	YES	NO	NO	YES	YES	NO	NO
Month FE	YES	YES	NO	NO	YES	YES	NO	NO
Year X Month FE	NO	NO	YES	YES	NO	NO	YES	YES
Postcode FE	NO	YES	NO	YES	NO	YES	NO	YES

Note: Table 8 reports the results from the time-falsification analysis by setting the falsified bilingual school designation time at January 2011. Control time and treatment time are designed to include house transactions of 3 years before and after January 2011. Columns (1)–(4) use a control area within the vicinity of the Brunswick South Primary School catchment area using the same postcodes while columns (5)–(8) include control area of expanded surrounding postcodes as is used in Tables 4 and 5. Time fixed-effect, postcode fixed-effect, and school_name fixed-effects are included as indicated in each column. Standard errors are clustered at postcode level. Robust T-statistics are given in parentheses. ***significant at 1%, ** 5%, * 10%

Table 9 Time falsification analysis—Other bilingual schools and similar public school areas

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Control Area	Other Bilingual School Area				Similar Public School Area			
VARIABLES	ln(Price)				ln(Price)			
Type	House				House			
After X Brunswick South Catchment	0.018	0.018	0.021	0.021	0.053	0.034	0.060	0.041
	(1.44)	(1.44)	(1.30)	(1.30)	(1.18)	(0.75)	(1.43)	(0.94)
Brunswick South Catchment	0.293***	−0.292***	0.287***	−0.300***	0.003	−0.097	−0.010	−0.107
	(38.91)	(−13.44)	(31.83)	(−15.04)	(0.05)	(−1.09)	(−0.20)	(−1.19)
No. of Bedrooms	0.179***	0.179***	0.179***	0.179***	0.182***	0.186***	0.182***	0.186***
	(9.09)	(9.09)	(9.16)	(9.16)	(7.91)	(8.38)	(7.81)	(8.26)
No. of Bathrooms	0.157**	0.157**	0.155**	0.155**	0.113***	0.116***	0.112***	0.114***
	(2.96)	(2.96)	(3.08)	(3.08)	(7.12)	(7.65)	(7.28)	(7.70)
No. of Parking Spaces	0.066***	0.066***	0.066***	0.066***	0.067***	0.065***	0.067***	0.065***
	(4.65)	(4.65)	(4.57)	(4.57)	(9.50)	(9.56)	(9.93)	(9.96)
Constant	12.187***	12.772***	12.071***	12.658***	12.318***	12.675***	12.411***	12.768***
	(83.60)	(77.70)	(38.53)	(38.35)	(256.98)	(173.87)	(180.67)	(118.77)
Observations	3086	3086	3086	3086	6315	6315	6315	6315
R-squared	0.671	0.671	0.683	0.683	0.620	0.607	0.632	0.618
School_Name FE	NO	YES	NO	YES	NO	YES	NO	YES
Year FE	YES	YES	NO	NO	YES	YES	NO	NO

Table 9 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Control Area	Other Bilingual School Area				Similar Public School Area			
VARIABLES	ln(Price)				ln(Price)			
Type	House				House			
Month FE	YES	YES	NO	NO	YES	YES	NO	NO
Year X Month FE	NO	NO	YES	YES	NO	NO	YES	YES
Postcode FE	YES	NO	YES	NO	YES	NO	YES	NO

Note: Table 9 reports the results from time-falsification analysis by setting the falsified bilingual school designation time at January 2011 with a control area containing other bilingual schools and public school catchment areas with similar NAPLAN performance. Control time and treatment time are designed to include house transactions of 3 years before and after January 2011. Columns (1)–(4) use a control area of other bilingual school catchment areas while columns (5)–(8) include a control group of school catchment areas with similar public primary schools that have shown similar performance in NAPLAN. Time, postcode, and school_name fixed-effects are included as indicated in each column. Standard errors are clustered at postcode level. Robust T-statistics are given in parentheses. ***significant at 1%, ** 5%, * 10%

response in the price. Thus, we conclude that the significant and positive increase in the housing price is a unique phenomenon only witnessed in the treatment area after the bilingual school designation.

Common Trend Analysis

To validate the results when the difference-in-difference method is used, we compare common trends by checking the statistical significance of the price difference *ex ante* and *ex post* using the equation below.

$$\ln(Price_{i,t}) = \alpha + \beta_1(Pre\_18\_MonthsXBrunswick\ South\ Catchment) + \beta_2(Post\_18\_MonthsXBrunswick\ South\ Catchment) + X'_{i,t}\theta + \gamma_t + \delta_{postcode} + \varepsilon_{i,t}. \quad (3)$$

In this specification, we use real estate transaction data from January 2013 to June 2017 and divide the total period into three 18-month terms. The first term, from January 2013 to June 2014, is used as a reference period; the second term, from July 2014 to December 2015, is the trend term, of which the coefficient should be insignificant to satisfy the common trend assumption of the difference-in-difference methodology. The last term, from January 2016 to June 2017, shows the difference in trend after the bilingual school designation. Table 10 reports the results of parallel trend analysis. The coefficient of *Pre_18 Months X Bilingual Catchment* is 0.020 in house submarket. Moreover, the coefficient during the trend term (July 2014 through December 2015) is statistically insignificant. However, the price trend in the subsequent 18-month period after the designation shows significant and positive difference by 14.2%. By this result, we can confirm that the common trend was similar across the treatment and control areas before the bilingual school designation, and each area starts to take a different path after the designation.

Confounding Factors

This section discusses factors associated with the housing price in the catchment area of Brunswick South Primary School and surrounding area. These factors are not captured in the regression model but could have influenced the conclusion of the analysis. These factors include the construction improvement project of a level crossing near the catchment area, variation in school performance, and immigration trends.

Removal of Level Crossing

The Melbourne government has been working on the level crossing removal project[18] at Moreland Road level crossing in Brunswick. The removal of the Moreland Road level crossing in Brunswick will be a major improvement for the 16,000 motorists who

[18] For more information about the level crossing removal project, please refer to https://levelcrossings.vic.gov.au/

Table 10 Common trend analysis

VARIABLES	(1) House ln (Price)
Pre_18 Months X Bilingual Catchment	0.026
	(1.48)
Post_18 Months X Bilingual Catchment	0.142***
	(5.56)
Hedonic factors	Included
Constant	12.449***
	(168.04)
Observations	10,351
R-squared	0.483
Year FE	YES
Month FE	YES
Postcode FE	YES

Note: This table reports the common trend analysis of the house price before and after the bilingual school designation in Brunswick South Primary School catchment area and the surrounding postcode areas. A reference period is set to include the price level between January 2013 and June 2014 (18 months) to compare the price trend in pre-designation (Pre_18 Months) for 18 months starting from July 2014 and post-designation period (Post_18 Months) for 18 months from January 2016. Hedonic factors of number of bedrooms, bathrooms, and parking area are included in the analysis. Standard errors are clustered at postcode level. Robust T-statistics are given in parentheses. ***significant at 1%, ** 5%, * 10%

use the road every day once it is finished. However, it might cause additional traffic cost to the local residents during the construction period. The design of this project is not yet finalized. However, it is scheduled to be completed by 2022. The proposed plan to remove the level crossing may have influenced the housing market in surrounding suburbs such as Brunswick, Brunswick West and Brunswick East. However, the location of the associated train station is located in the control group area. Even though the driving distance from the station to Brunswick South Primary School is less than 4 km, we believe that the removal project should have affected both treatment and control area altogether due to its location. For this reason, we conclude that the removal of level crossing does not affect our results.

School Performance

Another confounding factor is variation in the performance of Brunswick South Primary School. The average NAPLAN score of students in year 3 and year 5 is one of the most important measurements of primary school performance in Australia as we discussed in the Data and Methodology section. Table 11 below presents the change of average NAPLAN score of students in year 3 and year 5 at the Brunswick South Primary School from 2015 to 2018.

Table 11 NAPLAN score of students in the Brunswick South Primary School

	Year Three				Year Five			
	2015	2016	2017	2018	2015	2016	2017	2018
Reading	483	475	443	488	561	544	563	542
Writing	425	448	378	421	481	488	492	464
Spelling	450	453	419	436	522	504	519	513
Grammar	458	462	408	440	544	520	521	529
Numeracy	438	426	408	434	535	496	538	505

Note: This table reports the average NAPLAN score of year three and year five students in Brunswick South Primary School in five subjects (Reading, Writing, Spelling, Grammar and Numeracy) from 2015 to 2018

As the table shows, we do not observe systematic change of performance of students in year three and five in all five assessed subjects (Reading, Writing, Spelling, Grammar, and Numeracy) from 2015 to 2018 in spite of some fluctuation. This phenomenon is consistent with the overall school score by Better Education based on the enrolled students' English, Math and overall academic performance.[19] The Fig. 5 below shows the overall score by Better Education and total students' enrollment number of Brunswick South Primary School from year 2011 to 2018.

According to Fig. 5, the overall score of the Brunswick South Primary school, which is a standardized index of academic performance, did not change significantly over the years from 2011 to 2018. The total number of students enrolled did not change too much from year 2011 to year 2014, and then increased significantly after 2015 when the Brunswick South Primary school was converted to bilingual school. This phenomenon supports our argument that the conversion to bilingual school enhances the attractiveness of Brunswick South Primary School to the students and parents, and further leads to the increase of housing value within the catchment area.

Impact of Immigration

Melbourne is the second largest city in Australia and capital city of Victoria state, and it is famous for the diversity of its residents' cultural backgrounds and high quality of living. Thus, Melbourne has been attracting immigrants from overseas and other states. From 2015 to 2016, net immigration received to Victoria state was 81,706, of which 65,007 is net overseas immigration and 16,699 is net interstate migration.[20] Existing literature finds that people, especially immigrants,

[19] The ranking of primary schools by Better Education can be found at: https://bettereducation.com.au/Default.aspx

[20] The information regarding the statistics of immigration of Victoria is collected in the 2016 Censuses. The detailed information can be found at http://www.abs.gov.au/ausstats/abs@.nsf/mf/3412.0/

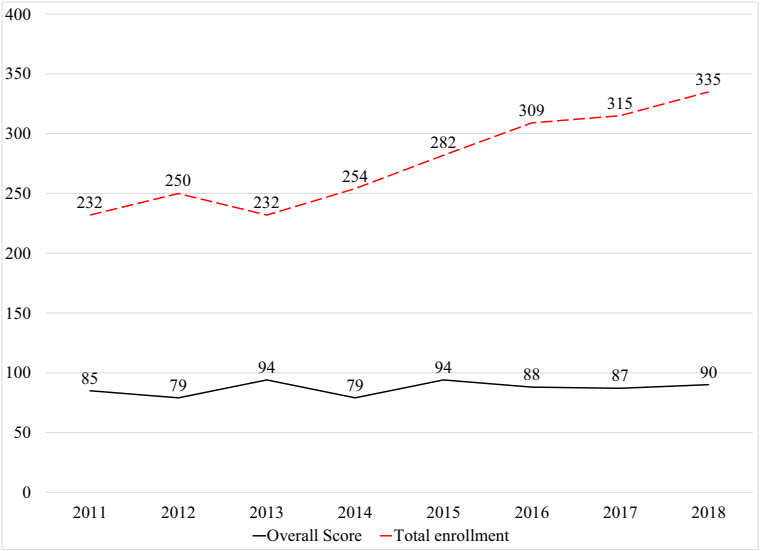

Fig. 5 Overall score and total enrollment number of Brunswick South Primary School. Note: This figure shows the State Overall Score, which is a standardized index of academic performance with a ceiling at 100 and a bottom at 60, by the Better Education and the total enrollment number of Brunswick South Primary School from year 2011 to 2018. <Source: https://bettereducation.com.au/SearchBetterEducation.aspx>

tend to live near neighborhoods with similar culture and social backgrounds. This phenomenon is known as ethnic or racial neighborhood segregation and could have a significant local and social effects on the labor market, consumption, housing, and transportation. (Cutler et al. 2008; Saiz and Wachter 2011). Also,

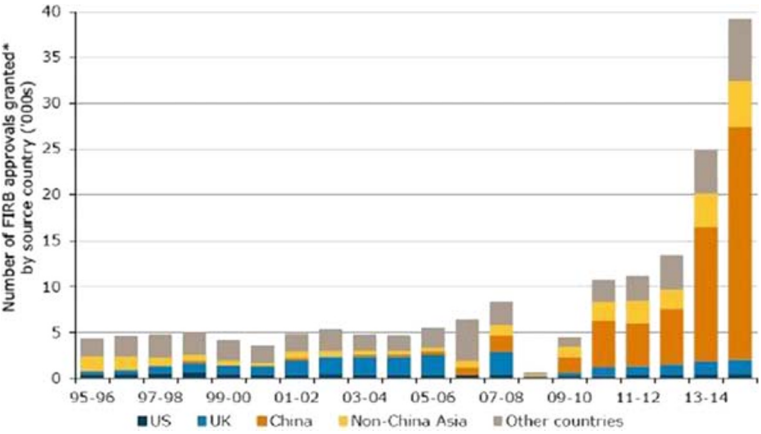

Fig. 6 Breakdown of origins of foreign investment into Australian housing market. Note: This figure shows the amount of foreign investment from different sources into the Australian housing market from 1996 to 2015. This figure is reproduced based on the data provided by the Australian Foreign Investment Review Board. Detailed information can be found at http://firb.gov.au/about/publication/

Table 12 Changes of ethnicity percentage for different suburbs from 2006 to 2011

	South-East Asia			North-East Asia (including China)			Southern and Central Asia			Eastern Europe (including Italy)		
	2006	2011	2016	2006	2011	2016	2006	2011	2016	2006	2011	2016
Segregation area for Asians												
Box Hill	8.3% (715)	7.9% (1372)	9.6% (1903)	21.3% (1835)	26.2% (4551)	34.4% (6821)	3.7% (319)	5.8% (1007)	5.8% (1150)	3.1% (267)	2.4% (417)	1.8% (367)
Box Hill North	6.1% (650)	6.6% (724)	7.8% (926)	10.7% (1139)	15.5% (1701)	21.2% (2517)	2.0% (213)	3.2% (351)	3.8% (451)	5.4% (575)	4.5% (494)	3.5% (416)
Box Hill South	5.2% (384)	5.6% (431)	6.3% (531)	6.5% (480)	10.1% (778)	14.6% (1231)	1.9% (140)	2.9% (223)	4.1% (346)	3.5% (259)	3.1% (239)	2.6% (219)
Glen Waverley	8.9% (3401)	10.0% (3920)	10.8% (4335)	10.5% (4013)	15.5% (6077)	20.3% (8186)	7.4% (2828)	9.6% (3764)	12.6% (5081)	4.5% (1720)	3.8% (1490)	3.1% (1250)
Doncaster	5.6% (1001)	6.8% (1248)	7.6% (1564)	11.8% (2110)	16.2% (2974)	21.6% (4446)	1.7% (304)	2.5% (459)	2.9% (597)	12.0% (2145)	10.5% (1928)	8.3% (1708)
Doncaster East	6.7% (1789)	7.7% (2083)	8.9% (2524)	11.7% (3124)	14.3% (3868)	19.1% (5417)	2.0% (534)	2.4% (649)	3.2% (908)	7.9% (2109)	7.2% (1947)	5.9% (1673)
Suburbs overlap with the catchment area of Brunswick South Primary School												
Brunswick	3.4% (707)	3.6% (820)	3.2%(784)	3.4% (707)	3.0% (683)	3.2% (781)	3.3% (686)	4.1% (933)	3.3% (808)	11.1% (2307)	9.0% (2049)	7.6% (1860)
Brunswick East	2.9% (215)	3.1% (263)	3.5% (403)	2.4% (178)	2.3% (195)	3.2% (368)	2.2% (163)	3.1% (263)	2.6% (299)	12.4% (919)	10.3% (873)	7.3% (840)
Clifton Hill	1.9% (102)	2.4% (139)	1.9% (120)	1.1% (59)	1.4% (81)	1.4% (89)	0.5% (27)	0.5% (29)	0.7% (44)	5.6% (302)	4.7% (272)	3.9% (247)
Carlton North	2.5% (152)	2.4% (149)	2.5% (158)	2.3% (140)	2.3% (143)	1.7% (107)	0.7% (43)	1.0% (62)	0.9% (57)	6.1% (371)	5.3% (330)	4.6% (290)

Note: This table reports the percentages and numbers of residents of different ethnicities for the suburbs of the Brunswick South Primary School catchment area and suburbs in an Asian segregation area from 2006 to 2011. The information is collected from 2006, 2011 and 2016 Census data. Detailed information can be found at http://www.censusdata.abs.gov.au/census_services/

it has been a topical issue as to whether Asian investors have driven up house prices in major gateway cities in Australia.[21] However, immigration should not impact our test results for the following reasons. Investment from Asian countries, especially China, is the main contributor to the dramatic growth of foreign investment into the housing market in the past ten years.[22] The picture below exhibits the proportion and amounts of different sources of foreign investment into the housing market over the past two decades Fig. 6.

However, the catchment area of Brunswick South Primary School and the suburbs that the catchment area overlaps with (Brunswick, Brunswick South, Carlton North, and Clifton hill as the green area in Fig. 2) are not a segregation area for people with Asian (including Chinese) background; however the area is popular for people with an Italian background. Table 12 below shows the percentage of resident's ethnicities for the suburbs of the Brunswick South Primary School catchment area and suburbs that are considered a segregation area for people with an Asian background.

As Table 12 shows, the percentage of people with Asian ethnicity increased significantly in Melbourne Asian segregation area from 2006 to 2011. More specifically, the percentage of residents with North-East Asian (including Chinese) ethnicity in Box Hill increased from 21.3% to 34.4% from 2006 to 2016. In contrast, the percentage of residents with Asian ethnicity in the suburbs overlapping with the catchment area of Brunswick South Primary School increases only slightly or even decreases from 2006 to 2016. For example, the proportion of residents with North-East Asian (including Chinese) ethnicity in Brunswick decreased from 3.5% to 3.2% from 2006 to 2016. Therefore, we can conclude that the catchment area of Brunswick South Primary School is not a popular area for Asian immigrants. Furthermore, the size of the catchment area is not big, only around five square kilometers, and it overlaps with several suburbs as shown in the Fig. 2. The green area, which is the vicinity area of overlapped suburbs, is used as a control group in the test. Thus, any impact of immigration on the local housing market should influence both the catchment area and green control group area in Fig. 2. Concluding above, the immigration and foreign investment should not impair our test results.

Robustness Test

Systematic Heterogeneity over Distance

The analysis with large postcode areas can be biased with systematic heterogeneity compared with other cases where the properties close to the boundary are analyzed. In this part, we show the results from an additional analysis to see if there are any systematic heterogeneity in distance. We use the samples used in Table 4 and set a dummy variable of *Outside* to the properties located outside of the Brunswick South Primary School catchment area and zero for those located within the catchment area. Then, we measure the distance from the

[21] Fuller story of the argument can be found at: https://www.abc.net.au/news/2017-10-06/impact-of-chinese-buyers-on-australian-house-prices/9021938

[22] Potential real estate buyers who are not citizens or permanent residents of Australis need to get approval from the Australian Foreign Investment Review Board in advance. Figure 5 shows the trend of approvals granted by the Australian Foreign Investment Review Board.

Table 13 Analysis on the systematic change in distance

VARIABLES	(1) ln(Price)	(2)	(3)	(4)	(5) ln(Price)	(6)	(7)	(8)
Sample Period	2014:1–2018:12				2014:1–2016:12			
Distance X Outside	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000
	(−1.35)	(−1.86)	(−1.43)	(−2.18)	(−1.06)	(−1.10)	(−1.13)	(−1.42)
Outside	0.096**	−0.035	0.102**	−0.031	0.104**	−0.017	0.110**	−0.014
	(3.83)	(−0.96)	(4.41)	(−0.93)	(3.80)	(−0.57)	(5.32)	(−0.55)
No. of Bedrooms	0.231***	0.213***	0.228***	0.210***	0.245***	0.220***	0.241***	0.216***
	(8.63)	(11.18)	(8.60)	(11.11)	(9.11)	(11.22)	(8.85)	(11.03)
No. of Bathrooms	0.075	0.063	0.075	0.063	0.071	0.063	0.070	0.061
	(1.37)	(1.27)	(1.38)	(1.27)	(1.30)	(1.28)	(1.29)	(1.28)
No. of Parking Spaces	0.046*	0.074**	0.049*	0.076***	0.039*	0.063**	0.042*	0.065**
	(2.54)	(5.60)	(2.84)	(6.07)	(2.42)	(4.12)	(2.60)	(4.40)
Constant	12.832***	13.110***	12.840***	13.105***	12.804***	13.116***	12.791***	13.083***
	(84.28)	(100.98)	(64.44)	(66.10)	(84.82)	(90.96)	(65.97)	(67.16)
Observations	2140	2140	2140	2140	1358	1358	1358	1358
R-squared	0.372	0.479	0.385	0.489	0.351	0.463	0.362	0.473
Year FE	YES	YES	NO	NO	YES	YES	NO	NO
Month FE	YES	YES	NO	NO	YES	YES	NO	NO
Year X Month FE	NO	NO	YES	YES	NO	NO	YES	YES
Postcode FE	NO	YES	NO	YES	NO	YES	NO	YES

Note: This table presents the change of house price in distance from the Brunswick South Primary School. We measure the distance from the Brunswick South Primary School to each house used in Table 4. The distance is interacted with Outside, which takes 1 for the houses located outside the catchment area, and the log-normalized house price is regressed on the interaction term with distance and other hedonic variables. Sample period from January 2014 to December 2018 is used in column (1)–(4), while two-year period from January 2014 is used in column (5)–(8). Robust T-statistics are given in parentheses. ***significant at 1%, ** 5%, * 10%

Table 14 Alternative model specification with boundary fixed-effects

VARIABLES	(1) ln(price)	(2)	(3)	(4)
After X Brunswick South Catchment	0.084**	0.083**	0.084**	0.083**
	(3.81)	(3.24)	(3.78)	(3.58)
Brunswick South Catchment	0.041	−0.095***	0.032	−0.099***
	(0.47)	(−13.45)	(0.35)	(−8.32)
Brunswick South Catchment X d_3054	0.231***	0.205***	0.239***	0.211***
	(30.03)	(28.25)	(45.46)	(35.54)
Brunswick South Catchment X d_3056	−0.146***	0.132***	−0.140***	0.134***
	(−24.43)	(26.85)	(−17.46)	(14.94)
Brunswick South Catchment X d_3057	−0.137***	0.161***	−0.132***	0.154***
	(−12.81)	(22.22)	(−23.02)	(16.18)
No. of Bedrooms	0.226***	0.212***	0.223***	0.209***
	(9.56)	(11.17)	(9.45)	(11.04)
No. of Bathrooms	0.075	0.062	0.076	0.062
	(1.47)	(1.28)	(1.47)	(1.28)
No. of Parking Spaces	0.046**	0.074***	0.048**	0.076***
	(3.51)	(6.04)	(3.93)	(6.49)
Constant	12.828***	13.035***	12.822***	13.029***
	(175.68)	(95.56)	(108.42)	(64.19)
Observations	2140	2140	2140	2140
R-squared	0.382	0.480	0.394	0.490
Year FE	YES	YES	NO	NO
Month FE	YES	YES	NO	NO
Year X Month FE	NO	NO	YES	YES
Postcode FE	NO	YES	NO	YES

Note: This table reports the results from alternative model specification by adding the Postcode-by-Brunswick South Catchment fixed-effect. Each postcode within the catchment area is allocated with a dummy variable (d_3054, d_3056, and d_3057) and interacted with the dummy variable of Brunswick South Catchment. Robust T-statistics are given in parentheses. ***significant at 1%, ** 5%, * 10%

Brunswick South Primary School to each location of house and interact the *Outside* dummy variable and *After* dummy variable. If the coefficient is significantly different from zero, this means that the houses located within the *Outside* is systematically affected by the distance from the Brunswick South Primary School. As the Table 13 shows, the coefficients of the interaction term is statistically and economically insignificant and we confirm that the issue of systematic heterogeneity does not exist in our study.

Boundary Effect within the Treatment Area

Dhar and Ross (2012) argues that long-lasting boundaries likely has a pronounced impact on the home buyers' decision. Thus, it is suggested that the average difference across districts even within the same school zone be controlled for. Following Dhar and Ross (2012), we add the fixed-effect of postcode-by-Brunswick South Catchment in

our model. Since there are four postcodes in the treatment area, three separate dummy variable for postcode 3054, 3056, and 3057 is generated and is interacted with the dummy variable of *Brunswick South Catchment*. Adding these fixed-effects assures that the heterogeneity across different postcode areas in terms of neighbourhood quality is eliminated.

Table 14 shows the results from the augmented model with postcode-by-Brunswick South Catchment fixed-effects. We find that the coefficients of our interest do not deviate significantly from our previous findings. Rather, the coefficients show narrower gap across different model specification after controlling for the postcode boundaries within the treatment area. This robustness analysis confirms that the tenor of your major finding is not deterred after controlling for the postcode boundaries.

Conclusion

This research investigates whether and how the adoption of bilingual education is capitalized into housing price. We conduct a quasi-experiment based on the unique event of converting a monolingual public primary school into a bilingual school in Melbourne. We find statistically and economically significant results indicating that the conversion from monolingual school to bilingual school leads to the increase of housing price in the subject school catchment area. The increase is statistically significant for houses which are usually occupied by families with children in Melbourne, but insignificant for units which are usually occupied by households with few or no school-aged children. The falsification tests reconfirm the positive effect of the bilingual school designation on the housing price. These findings imply that the benefits of bilingual education to the students is positively capitalized into the value of houses. Additional robustness test confirms that there are no issues related with systematic heterogeneity in distance. Alternative model specification with control for the boundary effect does not alter the major finding of this study.

Our findings provide the following contributions to the literature: Firstly, we find evidence for a new dimension of school attributes: that the adoption of a bilingual teaching system influences housing value. Secondly, this research contributes to the existing literature by proving that certain attributes of schools, such as the bilingual educational system, have heterogeneous impact on types of residential property (house and unit). In our sample of the Melbourne housing market, families with school-aged children usually occupy houses and care more about the bilingual education of the school, while families without children usually occupy units and care less about schools. Thus, certain attributes of school, such as the bilingual educational system, provide different housing value implications for different types of households/investors. Finally, this paper contributes to the literature by showing that the government policy aiming to improve the educational system by promoting bilingual education has unanticipated impact on housing value.

Traditional measurements of school quality such as school spending input, students general test scores and school ranking, which cannot capture all dimensions of the school attributes, face limitation in terms of reflecting the relationship of school quality to housing value. Thus, further research is needed to investigate other dimensions of school quality similar to the adoption of bilingual education in order to fully understand the housing market. Also, analysis over an extended time frame is required to see if this positive impact on the house price is long-lived effect or a temporary response that disappears in a few years.

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