Population, diversity, and restaurants: trends in the geography of cuisine variety in the Netherlands

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Over the past two decades, research in regional science has paid considerable attention to the benefits of urban density and proximity, even though there has been tremendous progress within the same period in technologies that ease the friction of distance (e.g. mobile communication, high-speed internet). Many scholars argue that in spite of falling transportation costs for tradable goods and the proliferation of information and communication technology cities will always have a vital edge in facilitating face-to-face communication. We argue that even if this is the case, there still remains a host of benefits that have come to rely less on urban density and this will have implications for the future of cities. In the current study we focus on one particular type of benefit associated with urban size and density – namely, the availability of a specialized array of urban amenities. More precisely, we use regional data on the distribution of restaurants in the Netherlands, and differentiate them according to their cuisine type. We explore how the presence of cuisine variety relates to population density and diversity, and whether these relationships vary across different city sizes. We find that the explanatory power of population density and diversity diminishes over time, especially in smaller cities. We argue that these trends support the hypothesis that a reduction of spatial information frictions reduces the need for urban density, as benefits associated with larger cities – such as cuisine variety – can be increasingly found in smaller cities.

Keywords:
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Introduction

For some time now, the academic debate over the foundations and benefits of agglomerations has been dominated by the notion of transportation costs. New economic geography models tend to explain agglomeration as a consequence of transportation costs of goods, increasing returns in production, and 'love of variety' among consumers (Krugman 1991). Other theories stress the increasing importance of passenger transportation costs compared to those of goods transport, and the importance of local knowledge spill-overs that require face-to-face contact (Glaeser et al. 1992, Jacobs 1969, Marshall 1890). Although the costs of exchanging information over space have fallen at rapid rates over the last 20 years – largely on account of the rise of (high-speed) internet and mobile communication technologies – the implications of this trend for the future of cities have been scarcely explored to date.

While face-to-face contact may still be the most efficient way to exchange certain types of knowledge, it seems that changes in information exchange costs cannot occur without having some effect on the spatial structure of the economy. Several early studies indicate that communication technologies such as the internet would at best contribute to the 'death of distance', and not so much to the 'death of cities'– meaning that there is an *urban bias* inherent in the benefits of these technologies (Kolko 2000, Leamer–Storper 2001, Panayides–Kern 2005, Sinai–Waldfogel 2004). A recent study by Anenberg and Kung (2015) convincingly shows that the rise of mobile internet has reduced *spatial information frictions* in the market for food truck lunches and led to an increase in local variety, thereby again complementing rather than substituting for urban benefits. Notwithstanding these studies we argue in the current study that the rise of the internet and mobile communication *does* substitute for the city by 1) making urban density less critical for efficient information exchange and 2) providing alternatives for diverse local populations.

Thus, the aim of this study is to illustrate the implications of reduced spatial information frictions on the benefits of agglomeration. We limit our approach by explicitly taking the perspective of people (i.e. consumers and workers) rather than that of firms, and by focusing on the *local variety effects* of agglomeration. We take the perspective of people because this is an understudied viewpoint in the abundant body of agglomeration literature; although this lacuna was identified over 15 years ago (Clark et al. 2002, Glaeser et al. 2001, Tabuchi–Yoshida 2000), extensive research on this topic is emerging only slowly. We choose to focus on *variety effects* because these are the most obvious urban benefits for people (Glaeser et al. 2001), and a large proportion of the research on the consumer effects of agglomeration has focused on these outcomes (e.g. Berry–Waldfogel 2010, Lee 2010, Schiff 2015, Tabuchi–Yoshida 2000, Waldfogel 2008). We operationalize the concept of local product variety with the variety of restaurant cuisines. Restaurants are typical local goods, and cuisine variety has always served as a prime example of the consumer benefits of agglomeration (Glaeser et al. 2001, Tabuchi–Yoshida 2000).

This study mainly serves to explore whether trends in the distribution of restaurant variety over the last 20 years *support* the hypothesis that a continuing reduction of spatial information frictions changes the effects of agglomeration and diversity on local product variety. We carefully address potential sources of bias and, to some extent, correct them by using the panel dimension of our data to control for the time-invariant characteristics of municipalities. The identification of specific mechanisms is left to future research.

This paper proceeds as follows. In Section 2 we review the basics of urban benefits for consumers and introduce the manner in which reducing spatial information frictions may render population density and local diversity less important vis-à-vis local product variety. We also present three hypotheses that we later test. Section 3 provides a brief history of restaurant cuisine variety in the Netherlands, and the associated institutional factors. Section 4 describes the data and methods used herein. Section 5 presents our analytical results – in which we test our three hypotheses – and Section 6 concludes.

Agglomeration theory and spatial information frictions

Agglomeration benefits for people: local variety

Over the previous century, the bulk of the literature has argued that cities are well-suited for production but not so much for consumption, given the presence of congestion, pollution, and crime (Glaeser et al. 2001). One of the first papers to pay empirical attention to the consumption benefits of cities argues as follows.

> *There are not only the agglomeration diseconomies, but also agglomeration economies, which are called economies of variety, on the consumption side. Consumers can choose more suitable goods and services from a larger variety in larger cities. They can also enjoy the "city lights" effects there. In addition, agglomeration economies also play a role in job search. Since there are diverse job types and numerous workers with various skills and knowledge in larger cities, jobs and workers tend to match more easily there (Tabuchi–Yoshida 2000, p. 71).*

Next to variety-, city lights- (or architectural beauty-), and labour market-matching effects, other researchers propose that sharing the fixed costs of local (public) goods as well as the general ease of interaction and idea transmission are among the benefits that cities offer (Glaeser et al. 2001).

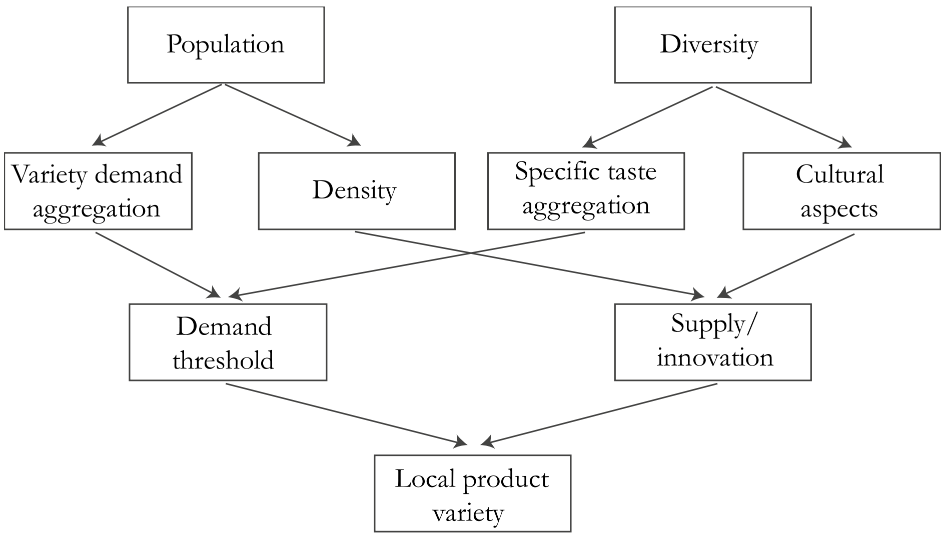
As previously mentioned, we focus on the variety effect of agglomeration. The literature explains the relationship between agglomeration and local product variety in different manners. According to central place theory and new economic geography, larger cities can foster more varieties due to the local aggregation of demand (Christaller 1966, Krugman 1991). Other theories stress the importance of diversity (especially ethnic diversity) in fostering a large variety of products (Jacobs 1969). According to this line of reasoning, it is not sheer city size but rather the demographic, social, and economic composition of cities that leads to more varieties.

We propose a conceptual model in which both population (density) and diversity affect local product variety through demand and supply effects. The demand effect of agglomeration is based on the notion that people have a 'love of variety'. Larger cities in this case aggregate the love of variety of many people and thus, are able to sustain a greater variety (Krugman 1991, Lee 2010). Agglomeration affects the supply side of urban product variety mainly by providing the density needed for quick interaction, face-to-face knowledge exchange, and the presence of different suppliers and other facilities that rely on some form of increasing returns (Glaeser et al. 2001). A large number of restaurants in larger cities may also induce competition on the basis of product characteristics rather than price, thereby increasing variety.

The demand effect of diversity is simple: when a cluster of people with the same taste reaches a certain threshold, product variety within a city increases. This relationship has been empirically confirmed for various products, including newspapers (George–Waldfogel 2003), radio stations (Waldfogel 1999), and restaurants (Schiff 2015). The supply effect of diversity relates to skills and cultural aspects. The supply of ethnic cuisine skills, for instance, is crucially dependent on the presence of specifically skilled cooks (Mazzolari–Neumark 2012). Next to that, a diverse socioeconomic environment is often argued to be conducive to innovation, because new combinations are more easily derived from different sets of ideas, values, and experiences (Feldman–Audretsch 1999, Jacobs 1969). Figure 1 provides a graphic overview of the aforementioned relationships. This figure ignores any possible reverse causality running from local product variety to population and diversity.

Figure 1

Conceptual framework: Population, diversity, and local product variety



Mechanisms and hypotheses

The forces that shape local product variety exist mainly because of transportation costs – or, more broadly, spatial transaction costs. The mechanism of demand aggregation works only for goods that are cheaper if they are produced around the corner rather than at a distance. In the same manner, density can lead to a better exchange of knowledge only if ideas can be transferred more efficiently across short distances – for instance, through face-to-face contact. It is important to note that transport costs have been continually evolving over time. Glaeser and Kohlhase (2004) show that the transportation costs of goods declined by 90% over the 20th century, and they argue that this phenomenon has changed the importance of fixed-infrastructure transportation. They contrast this trend with the remaining importance of the costs of moving people. By focusing on these passenger transportation costs, we argue that the increasing (and increasingly mobile) availability of information reduces uncertainty regarding destinations, and that it reduces the need to be at a particular location for certain activities. We present three hypotheses that we test later, in Section 4.

Reducing uncertainty about destinations

By reducing the uncertainty about destinations mobile communication technologies affect the costs of moving people and things from one place to another. Anenberg and Kung (2015) use the example of food trucks that provide up-to-date information on where they are located, thereby reducing for customers uncertainty about their whereabouts. This argument can be extended to things other than locational uncertainty: for example if the internet can give ubiquitous information on the quality of certain local products, people may be willing to travel longer distances.[1] If this is the case, the need for comparison shopping may diminish, thus reducing the need for clustering. In the case of restaurants, online review systems have indeed been shown to affect customers' purchasing decisions (Anderson–Magruder 2011), and the penetration rate of these websites is a strong predictor of (changes in) cuisine variety (De Vos–Meijers 2019). Overall, by increasing the willingness to travel for restaurants and reducing the need to cluster, we argue that urban density may have become less important with regard to local product variety. Therefore, our first hypothesis is as follows:

Hypothesis 1: Population density has become a less important determinant of restaurant variety in all cities.

[1] This relates to the idea that people have fixed travel time budgets, and that lower (generalized) transportation costs are generally offset by more travel (Fleischer–Tir 2016, Van Wee et al. 2006).

The question of whether this *uncertainty-reducing* mechanism has an urban bias leads to an ambiguous answer. With reference to Tobler's first law of geography,[2] we may assume that uncertainty about locations increases with distance. The uncertainty-reducing mechanism may thus affect more gravely the costs associated with travelling further. This means that at the neighbourhood level, communication technologies substitute for density to a lesser extent than is the case at higher spatial scales (e.g. city or metropolitan area). However, there is more asymmetry to this relationship if information is more easily and more abundantly transmitted from dense places (Panayides–Kern 2005). Indeed, even today, the coverage of glass-fibre internet and high-speed 4G mobile internet network is often, but not always, more extensive in urban areas than in rural areas. Therefore, communication technologies are likely a stronger substitute for urban density in lower-density places than in the densest locales.

Our second hypothesis is as follows:

Hypothesis 2: The importance of population density in explaining cuisine variety has decreased more quickly in smaller cities.

Reducing the need to be somewhere in particular

Another striking feature of the proliferation of mobile communication and interaction possibilities is that the need to be at a particular location to perform certain activities has decreased. Shopping for groceries or clothing can be done online, many job interviews today take place via Skype, and coffee shops are flooded with freelancers that no longer need an office. Although working from home has not completely supplanted the office, it has no doubt had consequences regarding traffic congestion. Many early studies stress that face-to-face contact will never be fully replaced by online communication, but we can safely assume that FaceTime and, perhaps in the near future, virtual reality conversations will substitute for face-to-face contact to a greater degree than fax or email.

Not only has the rise of information and communication technology meant that the people's *activities* are less bounded by the need to be in a certain location: the *influences of external factors on people* are also less bounded by space. The internet is a pool of knowledge about science, technology, culture, and the like. The serendipitous nature of diverse cities that, according to many scholars, remains so vital to innovation and technological advancement (Duranton–Puga 2001, Florida 2002, Glaeser et al. 1992, Jacobs 1969) is arguably even more noticeable on the internet. We go so far as to argue that technologies such as the internet have reduced the relative importance of local diversity for innovation and variety of local products by substituting local knowledge spill-overs. A point to be made here is that local diver-

[2] 'Everything is related to everything else, but near things are more related than distant things' (Tobler 1970, p. 236).

sity may also have become relatively less important given the increased global ease of travelling, which allows tourists to exert more demand for exotic varieties in tourist cities. Relating this *relaxation of spatial constraints* mechanism to cuisine variety in the Netherlands, we offer our final hypothesis:

Hypothesis 3: Local ethnic diversity has become relatively less important in determining restaurant variety.

History and institutional environment

Cities and the birth of restaurants

Historically, restaurants constitute an urban phenomenon. One of the first accounts to describe a restaurant (which is here defined as an eating house with a menu from which a customer can choose food items) comes from a historical observation of the Chinese city of Hangchow in the 13th century, which at the time was the largest city in the world (Kiefer 2002). Although subject to some discussion over which exact *établissement* was the originator, the first European restaurant was founded in Paris just before the French Revolution of 1789, around 1765 (Gault–Millau 1969, Spang, 2000). The French Revolution resulted in many jobless cooks that were previously employed by the aristocracy. As these cooks opened restaurants or were employed by other entrepreneurs, the restaurant industry developed rapidly in the late 18th-century Paris. The restaurant concept then dissipated to other European capitals, such as Brussels (Colliers 1993) and later, around 1850, also to the Dutch capital of Amsterdam. At that time, Amsterdam was recovering from a tumultuous first half-century, but incomes were on the rise again, and the *nouveaux riches*, in contrast to the old nobility, did not have objections to being seen eating in public.

The roles of trade, decolonization, and work migration

In the Netherlands, the emergence of cuisine variety was also something particularly urban (De Vos–Meijers 2019). In Rotterdam, the first Chinese restaurants opened around 1920, and in 1928 the first Chinese restaurant aimed at Dutch customers, ‘Kong Hing’, opened its doors in Amsterdam (Sanders 2008). During this time, Chinese sailors used to stay at predominantly Chinese-owned boarding houses while awaiting future employment, but the economic recession in the 1930s meant a decrease in demand for sailors. Meanwhile, boarding housekeepers were looking for ways to make their venture more profitable in times of economic downturn, and the first Chinese restaurants emerged from these boarding houses. By 1945, there were about 30 Chinese restaurants; fostered by an increasing demand for Asian food by colonists returning from Indonesia, this number grew to 225 by 1965. Many of these restaurants branded themselves as Chinese–Indonesian (Rijkschroeff 1998).

The decolonization process also resulted in the presence of Surinam restaurants in the Netherlands. Migration from Surinam to the Netherlands spiked in the years before Surinam's independence in 1975, and also four years later when it was announced that the lenient immigration policy for Surinam citizens would shortly be discontinued (Lucassen–Lucassen 2011). Immigrants from Surinam migrated for various reasons, including education, work, and the Surinam political environment. As people from Surinam clustered in large cities such as Amsterdam and Rotterdam, most Surinam restaurants are there. The Surinam cuisine is a mix of Creole, Chinese, and Indonesian cuisine, and so in the largest cities, the traditional blurring between Chinese and Indonesian cuisines goes one step further to Surinam cuisine.

Besides the trade- and colonialism-engendered Chinese–Indonesian and Surinam cuisines, there are several other widespread *migration-induced* ethnic cuisines in the Netherlands. Italian and Greek restaurants quickly gained footholds in Dutch cities during the 1960s and 1970s, when many Dutch companies employed migrant workers from the Mediterranean area. Nicolaas, Sprangers and Witvliet (2001) show that between 1965 and 1979, 44% of migrant workers returned to their respective home countries; however, 77% of Greek and Italian immigrants returned home during this period (i.e. 4,700 of 6,100, and 18,600 of 24,100, respectively). Still, these groups have made a lasting impact on the variety of cuisines offered in Dutch cities: even to this day, Italian and Greek restaurants can be found in virtually every small- and medium-sized city, alongside restaurants that serve Dutch, French, and Chinese food.

Other cuisines that can be traced back to large waves of work-related migration include those of Turkey and Morocco. Arguably, these cuisine types relate more closely to immigrant clusters than the Italian and Greek ones. Additionally, whereas the migration waves of Italian and Greek workers were followed by waves of remigration, migrant workers from Morocco and Turkey were more inclined to bring their families to the Netherlands. Between 1965 and 1979, a net total of 95,700 Turks and 61,100 Moroccans migrated to the Netherlands, and after 1974, almost one-half of these migrants arrived for family reunion reasons (Nicolaas et al. 2001).

Other peculiarities

We highlight two other specificities that have influenced the cuisine landscape in the Netherlands. First, the limitations of Dutch cuisine have led to many crossovers with other cuisines, most notably that of France. While during the 1960s all these ethnic cuisines were making their way to the Netherlands, the classical Dutch restaurant cuisine was, according to some, losing its quality, given the advent of stock powder, canned and deep-frozen vegetables, and ready-made products. In response to this downward trend, in 1967 19 Dutch restaurateurs started the Alliance Gastronomique Néerlandaise (AGN), which sought to bring craftsmanship back to restaurant kitchens, establish supply lines with French food producers, and ultimately promote culinary culture in the Netherlands (Klosse 1989). The fact that Dutch culinary culture was traditionally very modest meant that Dutch restaurants often already had to resort to the more pronounced Belgian and French ways of cooking. The AGN's efforts led to a further blurring of the lines among these national cuisines, at least in the Dutch context; therefore, it is not surprising that our data source does not distinguish between the two, and uses one category that includes both cuisines (i.e. 'Dutch–French').

Second, the geography of restaurant variety in the Netherlands is not shaped exclusively by the market. Since the 1980s, the Dutch government has put in place limits to the number of foreign-owned Chinese restaurants in Dutch municipalities (Koopman 2002).[3] Nowadays, migrants from outside the European Union (EU), United States, or Japan that want to open a restaurant need to show that their product has a 'genuine merit' for the Dutch economy (De Lange 2016). This means that the extent of cuisine variety is limited to some degree, and so we may expect that cuisines that relate to the EU, Japan, and the United States have a distribution different from those of other 'exotic' cuisines. Finally, there are several globalization-related cuisines in the Netherlands, including those of Argentina, India, Mexico, Thailand, and Vietnam (De Vos–Meijers 2019).

Data and methods

Data and descriptive statistics

The data used in this paper consist of a panel of Dutch municipalities from 1996 to 2011, and stem from the ABF Vastgoedmonitor. This source distinguishes 20 cuisine types, including a general *international* category and an 'other' category. Following Schiff (2015), we enrich this dataset with several municipality-level control variables. From Netherlands Statistics (CBS) we obtain information on local diversity, defined by the share of Western and non-Western foreigners. Here, 'Western foreigners' are defined as persons of whom at least one parent is born outside of the Netherlands, in either Europe (excluding Turkey), North America, Oceania, Indonesia, or Japan; 'non-Western foreigners', on the other hand, are people with at least one foreign-born parent from any other country. Our measure of diversity thus distinguishes Western and non-Western foreigners, but it does not address the extent to which specific ethnicities are concentrated. This measurement error may lead to the underestimation of the true effect of diversity. We also include household size, household income, and the shares of young (below 15 years) and old (65+

[3] Since only three small municipalities lacked a Chinese restaurant for a short period (i.e. Ouder–Amstel in 2006, Rozendaal in 2007, and Ouderkerk between 2007 and 2009), we do not expect this to influence our results.

years) people.[4] Furthermore, we use data from the ABF Vastgoedmonitor database regarding the number of hotel beds.

Table 1 shows the summary statistics of our data, aggregated over our study period. Municipalities had on average five cuisines, 28 restaurants, and 38,847 people each. Average household income slightly exceeded €30,000, and the average household contained 2.5 individuals. Furthermore, the average percentages of young, old, non-Western foreign people and Western foreign people were 14, 31, 5, and 7, respectively, and each municipality had on average 463 hotel beds.

Table 1

Summary statistics regarding cuisines in municipalities

Variables	(1)	(2)	(3)	(4)
	mean	sd	min	max
Number of cuisines	5.466	3.614	0	20
Number of restaurants	28.34	64.78	0	1,249
Population	38,847	59,628	3,413	779,808
Population density (per ha)	7.776	9.358	0.535	60.46
Share 'non-Western' foreign	0.0466	0.0450	0.00412	0.367
Share 'Western' foreign	0.0738	0.0438	0.00787	0.519
Number of hotel beds	462.9	1,957	0	46,189
Avg. household size	2.506	0.504	2	4
Avg. household income	30.71	5.408	18	59
Share old people	0.143	0.0289	0.0597	0.269
Share young people	0.305	0.0297	0.216	0.522
Year	2,004	4.610	1,996	2,011

Note: Number of observations: 6,640 and number of municipalities 394.

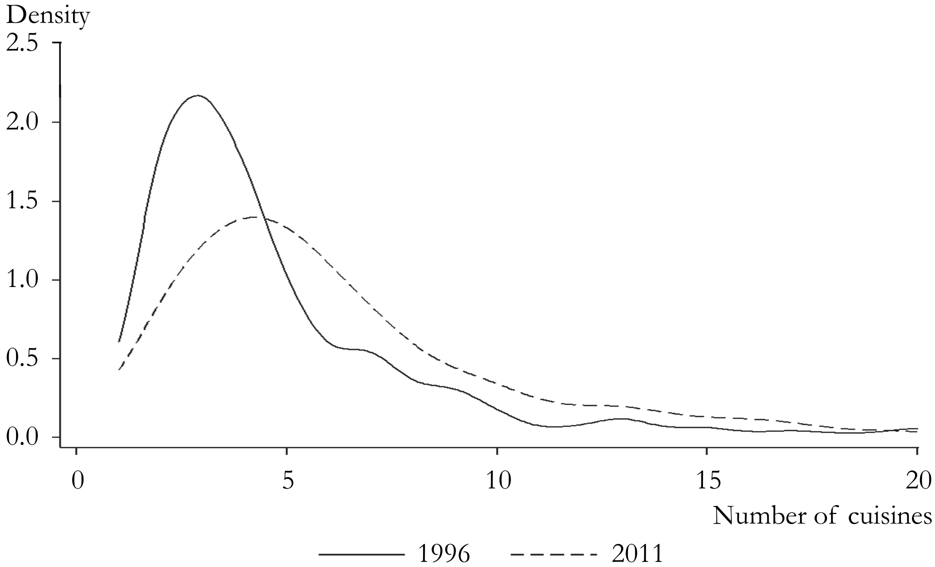
Figure 2 shows the distribution of the number of cuisines across the municipalities for the years 1996 and 2011. The emerging pattern suggests that between 1996 and 2011, the average municipal-level variety of cuisines increased; additionally, cuisine variety became somewhat more equally distributed across municipalities of different sizes.

Figure 3 shows the geographic distribution of cuisine variety over municipalities. This map shows clearly that cuisine variety increased nationally between 1996 and 2011.

[4] Household income data were missing for the years 1997, 2010, and 2011, in which case we use the income level of the nearest preceding year. We omit the small municipalities of Rozendaal, Schiermonnikoog, and Vlieland, because for confidentiality reasons, income information for the years 2006–2011 was not available.

Figure 2

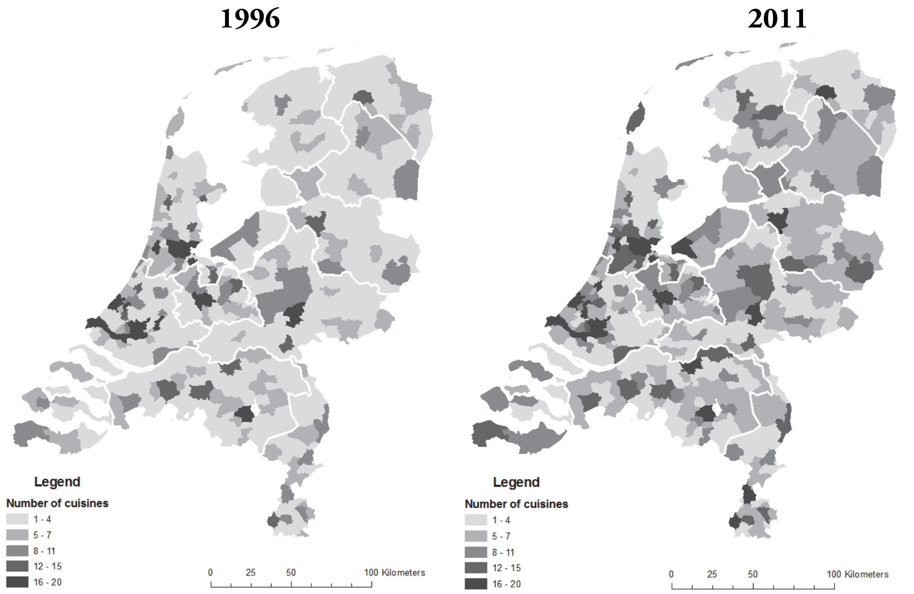
Distribution of the number of cuisines



Note: This density function is estimated using a Gaussian kernel and a rule-of-thumb bandwidth (Silverman 1986).

Figure 3

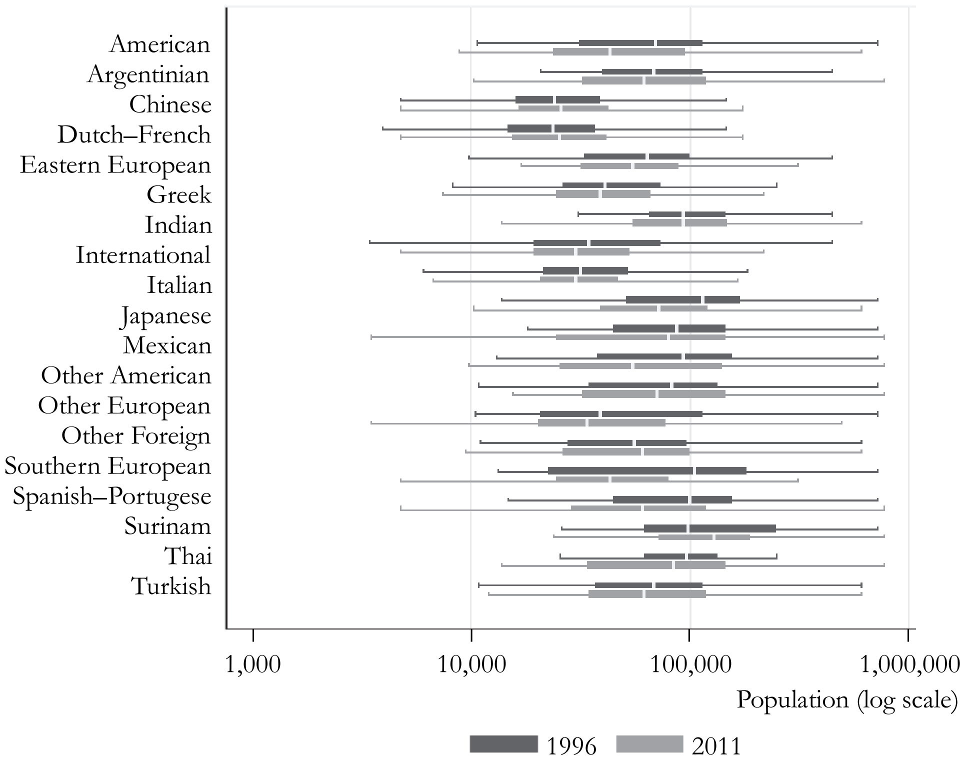
Maps of cuisine variety in the Netherlands in 1996 (l) and 2011 (r)*



* (l) – minimum; (r) – maximum.

Figure 4

Box plots of population in select municipalities for each cuisine type, in 1996 and 2011



Note: Outside values are excluded. The whiskers represent the minimum (l) and maximum (r) of the distributions (excluding. outliers), the boxes represent the areas between the first and third quartile of the distributions, and the white vertical lines in the middle of the boxes represent the median of each distribution.

Figure 4 features box plots that represent the distribution of population across choice cities – cities in which at least one restaurant with the cuisines in question is present – for each cuisine type, for the years 1996 and 2011. In this figure, several differences among cuisine types emerge. First, there are several varieties that show more or less the same distribution of choice cities in 1996 and 2011. These varieties include the Chinese, Dutch–French, Greek, Italian, Other Foreign, and Turkish varieties. Unsurprisingly, with the exception of the category Other Foreign, these are the varieties that have been around the longest in the Netherlands. Second, there are several cuisine types that seem to have become more regional, in the sense that in 2011 the distribution of choice cities contained smaller cities than the one of 1996. These cuisine types include the American, Argentinian, Indian, Japanese, Mexican, Other American, Other European, Southern European, Spanish–

Portuguese, and Thai varieties; these cuisine types are all more or less 'exotic'. Finally, the Eastern European, International, Other Asian, and Surinam cuisine types have become either more centred in medium-sized cities, or more urban. Overall this box plot shows that changes in the variety of cuisines may, for the most part, be explained by exotic rather than 'mature' varieties, and that net changes in cuisine variety may include the advent of new varieties and, simultaneously, the disappearance of other varieties.

Methodology

In analysing the relationship between agglomeration and urban benefits, it is of key importance to consider sources of bias. Omitting variables that, in our case, simultaneously affect cuisine variety and municipal population may lead to biased estimates (Angrist–Pischke 2008). Therefore, we employ a correlated random-effects approach (on which we elaborate below) that controls for all *time-invariant* characteristics of cities. However, there may still be *time-varying* municipal characteristics that correlate with both population and restaurant variety. Therefore, in our regression models, we control for several important time-varying city characteristics.

Reverse causality is another issue that may lead to bias. This would be the case if cuisine variety were an important pull factor for people. One way of addressing this issue is to use historical instruments for population, in a two-stage least squares regression. Using the 150-year lag for population essentially rules out the possibility of reverse causality. Schiff (2015) employs such an approach in his analysis of the relationship between population and cuisine variety. His instrumental variable estimates are similar to his ordinary least squares estimates, and so there seems to be little reverse causality. Furthermore, research on the pull factors of cities corroborates that consumer amenities – including cuisine variety – are minor pull factors compared to business factors (Chen–Rosenthal 2008). Therefore, in the current study, we focus on controlling for omitted time-invariant variables, and we do not control for reverse causality.

We use a log–log specification, as is customary in this literature stream. Our empirical model closely resembles those of Schiff (2015) and Berry and Waldfogel (2010); however, our data allow us to employ panel-data techniques, and this approach is quite unique in the literature. The standard approach would be to use municipality fixed effects, and while doing so would lead to unbiased estimates, this method can be very inefficient, especially with data that show limited variability. We therefore use the more flexible correlated random effects (CRE) method (Bell–Jones 2014). This is essentially a random-effects model (i.e. includes a specific error term for each otherwise fixed effect) combined with covariates that represent the panel-level mean. As such, this method is asymptotically identical to the fixed-effects approach, and even preferable for small samples (Dieleman–Templin 2014). Furthermore, it relates to the classic approach of Mundlak (1978), in that it allows one to test whether there is correlation between unobserved heterogeneity and the model covariates. The CRE model nonetheless has several limitations—in particular, regarding the assumptions concerning the unobserved (random) effect (Wooldridge 2002). Therefore, we will test the sensitivity of our results by estimating a fixed-effects model—a model which does not include between effects, but which relies on less-stringent assumptions, allowing for correlations between the unobserved effect and the dependent variable.

We include random effects at the municipality level. This leads to the following specification:

$$V_{mt} = \alpha + \beta(P_{mt} - \bar{P}_m) + \gamma(X_{mt} - \bar{X}_m) + \delta\bar{P}_m + \kappa\bar{X}_m + \theta_t + \omega_{mt} \quad (1)$$

where V_{mt} is the logarithm of cuisine variety in municipality *m* in year *t*, *P* is the logarithm of municipal population density, *X* is a vector of municipal control variables, θ_t are year-specific parameters, and $\omega_{mt} = \eta_m + \epsilon_{mt}$. The 'within' coefficients (β and γ) measure the effect of changes in the independent variable on changes in *V*, whereas coefficients δ and κ measure the extent to which the 'between' coefficients differ from the within coefficients. Furthermore, it should be noted that since the denominator of population density (area) varies only between municipalities (i.e. not over time), the interpretation of the within coefficient β differs slightly from that of the between coefficient δ: β should be interpreted as the estimated change in cuisine variety due to a change in population over time, and δ should be interpreted as the extent to which the (cross-sectional) effect of population density differs from the effect of population changes.

To test hypotheses 1 and 3 – which concern the existence of trends in the population and diversity effect, respectively – we examine changes in the effect of population, the share of immigrants, and the number of hotel beds on cuisine variety by allowing the coefficients to vary over time. To test hypothesis 2 – which concerns the differential trends between higher-density and lower-density places – we interact the population–time interaction with a dummy variable that indicates whether or not the municipal population density exceeds the median density.

Results

Table 2 presents the regression results. In column (1), we estimate the basic CRE model without year interactions, including the panel-level mean of all covariates. The results show that the 'within' effect – which stems from year-to-year variability within municipalities – of population density is characterized by an elasticity of 0.366, which means that a 10% population increase leads to 3.66% more cuisine variety. This is comparable to Schiff's (2015) lower-bound estimate of the elasticity between population and cuisine variety. The other 'within' coefficients are consistently not significantly different from 0. Among the included parameters for 'mean covariates' – which represent the difference between 'within' and 'between' effects –

average household size, income, share of non-Western foreigners, and number of hotel beds all significantly differ from zero. For these variables, the between effects differ significantly from the within effects. This is due, for example, to unobserved cross-sectional differences between municipalities that correlate with these variables.

We proceed to test hypotheses 1 and 3 – that is, to investigate trends in the effects of population density and diversity on product variety. In column (2), we include time-period dummy interactions for the effects of population density, the share of non-Western foreigners, and the share of Western foreigners. We also control for time-period interactions with the effect of the number of hotel beds, to account for changes in the importance of tourism. The results show that the effect of population density decreased from 0.406 to 0.356 (–12%) between the 1996–2001 and 2007–2011 periods, although the standard errors are large. The effect of the share of non-Western foreigners also decreased. In the 1996–2001 period, the estimated coefficient equals 0.972; this implies a 0.98% increase in cuisine variety for every one-percentage-point increase in the share of foreigners.[5] The estimated coefficient for the 2007–2011 period equals 0.944, and corresponds to a 0.95% marginal effect. Therefore, according to this model, the decrease in the effect of the presence of non-Western foreigners on product variety is extremely small. Estimates of the effects of the share of Western foreigners do not differ significantly from zero, and the number of hotel beds shows a small but significant ($p = 0.1$) effect only for the final period (i.e. doubling the number of hotel beds leads to a 2.42% increase in cuisine variety). From this latter result we may conclude that while tourism may be gaining importance in determining cuisine variety, its effect is extremely small. With the exception of the share of non-Western foreigners, all parameters for 'mean covariates' that were significant in the previous regression are now significant.

In the final regression model, we tackle hypothesis 2; here, we investigate whether the relationship between population density and cuisine variety has decreased more quickly in lower-density areas (i.e. municipalities with a population density lower than the annual median). Indeed, the decrease in importance of population density seems to have been graver for below-median-density municipalities: the elasticity estimate went from 0.461 in 1996–2001 to 0.342 in 2007–2011 (–26%), whereas for above-median-density municipalities during the same period, it went from 0.381 to 0.325 (–15%). Interestingly, population density initially seems to have affected product variety more in lower-density cities, but during our study period, the effect converged across cities of different sizes, even as there is also a general downward trend.

[5] In our data, shares range from 0 to 1. Considering that the dependent variable is presented in log form, we convert the coefficient value into a marginal effect of a one-percentage-point increase by using the formula $\exp(\beta*0.01)-1$, where β represents the coefficient value.

Table 2

Regression results. Dependent variable: Number of cuisines (log)

Variables	(1)		(2)		(3)	
Population density (log)	0.366*	(0.206)				
*1996–2001			0.406**	(0.202)		
*2001–2006			0.379*	(0.202)		
*2007–2011			0.356*	(0.203)		
Pop. density (log) *1(Pop. Density < P50)						
*1996–2001					0.461**	(0.202)
*2002–2006					0.406**	(0.206)
*2007–2011					0.342	(0.211)
Pop. density (log) *1(Pop. Density > P50)						
*1996–2001					0.381*	(0.201)
*2002–2006					0.352*	(0.201)
*2007–2011					0.325	(0.203)
Share 'non-Western' foreign	0.365	(0.343)				
*1996–2001			0.972**	(0.481)	0.970**	(0.471)
*2001–2006			0.948**	(0.419)	0.943**	(0.412)
*2007–2011			0.944**	(0.407)	0.931**	(0.399)
Share 'Western' foreign	0.629	(0.532)				
*1996–2001			0.729	(0.579)	0.749	(0.579)
*2001–2006			0.824	(0.598)	0.819	(0.598)
*2007–2011			0.920	(0.629)	0.881	(0.628)
Number of hotel beds (log)	0.0186	(0.0121)				
*1996–2001			0.0130	(0.0125)	0.0140	(0.0124)
*2001–2006			0.0183	(0.0123)	0.0189	(0.0122)
*2007–2011			0.0242*	(0.0135)	0.0241*	(0.0134)
Avg. household size (log)	–0.0525	(0.0445)	–0.0369	(0.0441)	–0.0291	(0.0435)
Avg. household income (log)	–0.00222	(0.187)	0.0463	(0.192)	0.0292	(0.191)
Share old people	0.638	(0.432)	0.711	(0.439)	0.823*	(0.430)
Share young people	–0.332	(0.476)	–0.377	(0.477)	–0.258	(0.468)
Between effects						
Population density (log)	–0.255	(0.206)	–0.271	(0.203)	–0.240	(0.202)
Share 'non-Western' foreign	0.985**	(0.460)	0.393	(0.589)	0.404	(0.580)
Share 'Western' foreign	–0.429	(0.565)	–0.615	(0.621)	–0.587	(0.620)
Number of hotel beds (log)	0.153***	(0.0191)	0.153***	(0.0188)	0.153***	(0.0186)
Avg. household size (log)	–0.435**	(0.185)	–0.450**	(0.184)	–0.517***	(0.188)
Avg. household income (log)	–0.599**	(0.288)	–0.648**	(0.291)	–0.623**	(0.291)
Share old people	–0.0321	(0.702)	–0.121	(0.699)	–0.255	(0.698)
Share young people	1.089	(0.744)	1.131	(0.743)	1.060	(0.734)
Constant	0.851**	(0.339)	0.871***	(0.338)	0.848**	(0.339)
Year dummies	Yes		Yes		Yes	
Municipality random effects	Yes		Yes		Yes	
Observations	5,940		5,940		5,940	
R-squared	0.629		0.630		0.629	
Number of municipalities	394		394		394	

Note: Cluster-robust standard errors in parentheses, next to coefficient estimates. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 3 in the Appendix shows that these results are robust to a model specification with fixed effects, instead of (correlated) random effects.

Conclusion

Review of hypotheses

Our first hypothesis was that between 1996 and 2011, population density became less important in determining local product variety. Our results show that, overall, the elasticity of cuisine variety with respect to population density decreased by 12%. It remains to be investigated whether it is indeed the progress in (mobile) communication technologies that underpins this trend. Even more pressing is the question of the extent to which this result implies that accessibility is increasingly substituting for urban density as the spatial extent of agglomeration externalities increases. This topic is outside the scope of the current study, and we leave it for future research.

Our second hypothesis concerns the existence of an urban bias in the decreasing importance of population density. Our results show clearly that the elasticity between population density and cuisine variety was considerably greater in below-median-density municipalities; however the convergence of this elasticity between low- and high-density municipalities suggests that lower-density areas have indeed become able to sustain more variety with less density, while higher-density areas have experienced a more modest decrease in the importance of density. This finding aligns with those of earlier research, and implies again that communication technologies contribute more to the 'death of distance' than to the 'death of cities' (Kolko 2000). The overall decreasing importance of density does, however, imply that cities will not stay the same if the demand for density will indeed also decrease.

Our final hypothesis relates to the effect of local diversity on local product variety. We conjectured that this effect should have become less important in explaining product variety, as the internet has become an increasingly fruitful substitute for knowledge spill-overs and innovation. According to our estimates in Table 2 column (2), this seems hardly the case, as the effect of the concentration of non-Western foreigners has remained relatively stable over time. Meanwhile, the effect of local tourism – proxied by the number of hotel beds in a municipality – has become somewhat more important. It does not, however, entirely compensate for the decreasing importance of ethnic diversity, which suggests that ethnic diversity as a driver of local product variety (through innovation) may have been replaced by better communication technologies. Given the absence of a significant decrease, this hypothesis remains unconfirmed.

Directions for future research

The findings of this study give rise to several questions. First, the outlined trends indicate only a decline in the importance of urban density for variety; we can by no means establish that this is caused by advancing information and communication technologies. To identify the causal effect of such technologies, one strategy would be to find a credible source of random variation in the supply of communication technologies over space. Anenberg and Kung (2015) suggest, for instance, that the introduction of 3G-capable base stations may exhibit such random variation. Another approach would be to analyse the relation between information technology usage and cuisine variety. De Vos and Meijers (2019) do this by examining the effect of review website penetration rates on cuisine variety, conditional on historical variety.

Second, the future of cities depends not only on the cuisine variety effects that relate to urban density: on the contrary, this is only a tiny part of the puzzle of why people choose to live in cities (Chen–Rosenthal 2008). Further research may additionally examine whether urban density has become less important for labour market-matching externalities. Considering the increased possibilities for telecommuting and online job searches, this does not seem extremely farfetched (De Vos et al. 2018). In this case, the main challenge would again be to establish a causal relationship between communication technologies and the declining importance of urban density.

Third, while cities are beneficial for people, they are also associated with pollution, congestion, and crime (Glaeser et al. 2016). The interaction of information and communication technologies with these so-called agglomeration diseconomies is an understudied theme. While their effects on pollution may be limited, recent research suggests that the internet and mobile phones have lured criminals away from city streets (Edlund–Machado 2019). We may also expect some effects with regard to congestion, as many of today's navigation apps make it possible for one to choose the fastest route given current traffic conditions, and new cars are increasingly equipped with software that provides real-time routing and parking information.

Finally, over the last 20 years, a lot more has changed than just communication technologies. One of the other potential drivers is of course globalization (i.e. increased ease of travelling, EU integration, visa arrangements, etc.). We already alluded to one way in which globalization may substitute for local population, through demand exerted by tourists. In a similar fashion, outbound tourism may substitute for local knowledge spill-overs. This issue relates to the literature on city networks that suggests that as a driver of urban economic performance and the supply of functions, embeddedness in global networks is gaining importance relative to city size (Burger–Meijers 2016, Capello 2000, Johansson–Quigley 2004).

APPENDIX

Table 3

Fixed-effects models

Variables	(1)		(2)		(3)	
Population density (log)	0.365*	(0.206)				
*1996–2001			0.403**	(0.203)		
*2001–2006			0.376*	(0.202)		
*2007–2011			0.353*	(0.204)		
Pop. density (log) *1(Pop. Density < P50)						
*1996–2001					0.482**	(0.205)
*2002–2006					0.427**	(0.209)
*2007–2011					0.364*	(0.214)
Pop. density (log) *1(Pop. Density > P50)						
*1996–2001					0.378*	(0.201)
*2002–2006					0.349*	(0.201)
*2007–2011					0.323	(0.203)
Share 'non-Western' foreign	0.346	(0.343)				
*1996–2001			0.953**	(0.479)	0.955**	(0.469)
*2001–2006			0.928**	(0.418)	0.928**	(0.411)
*2007–2011			0.926**	(0.406)	0.916**	(0.398)
Share 'Western' foreign	0.632	(0.532)				
*1996–2001			0.739	(0.578)	0.764	(0.579)
*2001–2006			0.835	(0.598)	0.834	(0.599)
*2007–2011			0.931	(0.629)	0.895	(0.628)
Number of hotel beds (log)	0.0185	(0.0121)				
*1996–2001			0.0130	(0.0125)	0.0142	(0.0124)
*2001–2006			0.0182	(0.0123)	0.0189	(0.0121)
*2007–2011			0.0233*	(0.0135)	0.0235*	(0.0134)
Avg. household size (log)	-0.0541	(0.0445)	-0.0384	(0.0441)	-0.0301	(0.0435)
Avg. household income (log)	0.00352	(0.187)	0.0506	(0.192)	0.0378	(0.191)
Share old people	0.627	(0.432)	0.695	(0.439)	0.818*	(0.431)
Share young people	-0.316	(0.476)	-0.359	(0.477)	-0.234	(0.468)
Constant	0.308	(0.338)	0.200	(0.344)	0.156	(0.343)
Year and municipality FE	Yes		Yes		Yes	
Observations	5,940		5,940		5,940	
R-squared	0.249		0.257		0.262	

Note: Cluster-robust standard errors in parentheses, next to coefficient estimates. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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