Journal of Cultural Economics
https://doi.org/10.1007/s10824-021-09410-x

ORIGINAL ARTICLE

The China museum visit boom: Government or demand driven?

Fenghua Zhang[1] · Pascal Courty[2]

Received: 8 February 2020 / Accepted: 23 February 2021

Abstract
Visits to Chinese museums have grown eightfold between 1995 and 2016. Growth in museum expenditure and space has contributed to most of the increase in visits, although the free admission policy that was rolled out in 2008 also had a significant impact. Demand factors have not had a major impact on museum visit growth with the possible exception of the increase in urban population. Museum demand exhibits decreasing returns in museum quality and museum space but constant return to scale in both. Finally, the government's move to free admission, as well as the growth rates in museum space and expenditure, is broadly consistent with the objective of maximizing visits.

Keywords Museum demand · Museum visits · China · Cultural investment · China museum boom

JEL Classification Z1 · Z18

1 Introduction

China has been building thousands of museums over the past 20 years (Bollo & Zhang, 2017). Sceptics have questioned the Chinese government's aggressive museum supply policy (The Economist, 2018). Showing that museum visits have exploded, as is indeed the case, will not end the debate. To find out whether museums create their own demand, it is necessary to disentangle changes in museum supply from other changes that have simultaneously taken place within the Chinese society such as the growth of cities, and the steady increase in income and education. On the supply side, it is also important to untangle the role played by

✉ Pascal Courty
pcourty@uvic.ca

1 National Institute of Cultural Development, Wuhan University, Wuhan, China

2 Department of Economics, University of Victoria, and CEPR, Victoria, Canada

increasing the number and size of museums, enhancing visitor experience, and lowering admission fees.

This paper investigates the China museum visit boom using data from the Statistical Yearbook of Cultural Relics of China (SYCRC), which is published by the Ministry of Culture and Tourism (MCT). We use the yearbooks for years 1997 to 2016 to construct a panel of 20 years and 28 provinces. We leverage the panel nature of the dataset to estimate the impact on museum visits of changes in supply (museum size, quality, and count, and admission fee) and demand (urban population, income, and education). Most Chinese museums are public, and the decentralized approach to policy execution in China generates significant variations in supply variables over time and across provinces. Conditional on standard demand shifters, we argue that a difference in difference approach (time and province) is a powerful method to estimate the impact of supply factors. Thus, we follow a reduced form approach, but use time-series techniques to tackle non-stationarity issues and dynamic demand responses. We start by estimating a demand model using a first difference panel approach. We also use an autoregressive distributed lag (ARDL) panel model because we cannot reject the existence of cointegration and because the ARDL model allows for flexible short- and long-term responses to changes in explanatory variables.

This paper makes three main contributions to the museum literature. First, we leverage unprecedented variations in admission fees to estimate the elasticity of demand. Consistent with the literature (Frey & Meier, 2006), the long-term price elasticity is around − 0.16, while the short-term elasticity is around − 0.1. Two other supply variables are consistently statistically significant across a number of specifications and robustness tests. Museum space measures the total museum area available to the public, and it changes over time because provinces build new museums and expand existing ones. Museum expenditure includes spending on staff, exhibits, conservation, and other expenses made each year to run museums. We follow the literature and use expenditure as an indicator of museum quality (Luksetich & Partridge, 1997). Museum visits increase at a decreasing rate with museum quality and museum space. More surprisingly, we find constant return to scale in both museum characteristics: Total visits double when both expenditure and space double. Although visits display satiation when each museum characteristic is considered independently, it shows no satiation when both increase simultaneously.

Second, we estimate the contribution of supply and demand variables in explaining the China museum visits boom. Visits have increased from less than 100 million at the beginning of the sample period to the staggering 800 million figure 20 years later. The visit boom can be decomposed into three major components: massive increases in museum quality and size, and a dramatic reduction in admission fees after 2008. The increase in urban population also contributes to the increase in visits but to a much lesser extent. We do not find any role for education or income. Overall, the visit boom is largely driven by major changes in museum supply that have been orchestrated by government policies geared toward subsidizing cultural investment and stimulating the cultural sector.

Third, we analyze the government's choice of resource allocation focusing on three supply variables. The government can: (i) subsidize visits through lower admission fees, (ii) offer more choice through an increase in museum space, and (iii) increase the quality of visits through an increase in museum expenditure. We compare the government's chosen allocation against the allocation that maximizes museum visits. We derive conditions on the demand function, such that the optimization problem has an interior solution for the admission fee, and show that these conditions do not hold in our application. Instead, it was optimal throughout the sample period to decrease the admission fee toward zero. This rationalizes the government's policy of introducing free general admission in 2008 and the finding that the ratio of expenditure to admission revenue has increased throughout the sample. The coefficient estimates also require museums to invest roughly the same monetary value in expenditure and space. This identity implies that the growth rates of museum space and museum quality are optimal if the growth rate in the cost of museum space (land and building) is between 7 and 15 percent depending on the specification. Interestingly, the Chinese growth rate in real estate cost falls in between these figures. Overall, the analysis suggests that museums have changed the fee for general admission and allocated budgets between quality and space, in a manner that is consistent with the objective of maximizing visits.

This work contributes to two main strands of the literature. First and foremost, the stylized facts about changes in museum visits contribute to the small and emerging literature on cultural development in China (Keane, 2000) and the still smaller literature on the China museum boom (Bollo & Zhang, 2017; Varutti, 2014). Zhang and Courty (2020) show that a museum supply boom has taken place in China between 1997 and 2016, which has greatly affected museum count, size, quality, accessibility, and affordability. While Zhang and Courty (2020) study the China museum *supply* boom (CMB), this work documents a similar explosion in museum *visits* and investigates the role played by supply and socioeconomic changes. The evidence discards the speculation that the CMB has created many ghost museums that have few visitors. Instead, we show that increasing provincial museum space has a significant impact on visits. Museums do create their own demand. Although we rule out the possibility that this response is driven by a few superstar museums, it is still possible that some provincial museums are sometimes empty, but the evidence shows that this does not hold for the average provincial museum.

Second, this work contributes to the literature on the economics of museums (Camarero et al 2011; Fernandez-Blanco & Prieto-Rodriguez, 2020; Frey & Meier, 2006; Macdonald, 2011) and our empirical analysis is closely connected to the literature on museum demand and cultural participation. While the literature has largely focused on price and income elasticity, our work shows that supply factors affecting the quantity and quality of museums have played a dominant role in China during our sample period. Our analysis of the sudden move to free admission contributes to the controversial debate about museum financing (Anderson, 1998; Johnson & Thomas, 1998; O'Hagan, 1995). The finding that expenditure has an important impact on visits is consistent with Luksetich and Partridge (1997), and our contribution is to compute the trade-offs between lowering admission fees and increasing expenditure and space in stimulating demand.

The rest of this paper is organized as follows. Section 2 presents background information about museum policy in China, reviews the literature, and introduces the theoretical framework. Section 3 introduces the data, summarizes the CMB, and outlines the empirical demand model. Section 4 presents the results, Sect. 5 discusses implications for the debate on ghost museums, and Sect. 6 concludes.

2 Background, museum studies, and theoretical framework

We review policy changes that are relevant to the China museum boom, largely drawing from Zhang and Courty (2020), discuss the literature on museum visits, and use this information to present a theoretical framework that establishes the foundation for the empirical analysis and the interpretation of the results.

2.1 China's museum policy

There were only around 400 museums in China in 1980, and this figure grew to about 1200 in 1996, which marks the beginning of our sample period (Bollo & Zhang, 2017). By the end of the sample period, there were almost 4000 museums and the majority of these museums were public. The building boom occurred after two decades of enormous economic growth and massive investments in urban infrastructure. The development of the cultural sector is relatively recent and was part of the government's response to social transformations and changes in people's expectations and aspirations (Keane, 2000). Zhang and Courty (2020) show that between 1996 and 2015 museum expenditure has increased faster than public cultural expenditure, which has itself increased faster than GDP. They also document a major policy supply shift around 2007–2008 when the government has significantly increased museum subsidies, partially decoupled museum investments from regional GDP growth, added many small and local museums, and made most museums free for general admission.

According to Varutti (2014, p.4), 'museums in China largely remain enshrined in an authoritative monodirectional paradigm.' Cultural policy was elevated to the status of national priority in 2006 when it first appeared explicitly in the 11th Chinese Five Year Plan.[1] National plans give general direction for economic and social development that are complemented by specific plans issued by relevant government agencies. The Ministry of Culture and Tourism (MCT) is responsible for the implementation of China's cultural policies. MCT's plans give general directions for museum development and set specific objectives including targets for museum growth count, exhibits, and number of visitors. In 2006, for example, in response to the 11th national plan, MTC issued a 5-year Plan for Cultural Construction that stipulated that 'by 2010, the total number of museums in the country will reach 2600.'[2] A few years later, MCT stated in a new plan that the number of Chinese museums should reach 3500 by 2015.

1 http://www.cnr.cn/newstop/t20060317_504181100_12.html (Chapter 44).

2 11th Five-year Plan for Cultural Construction, http://www.china.com.cn/policy/txt/2006-11/09/content_7342376_5.htm

From a jurisdictional point of view, each museum is managed by one of four administrative levels of government (Varutti, 2014): central/national, provincial, municipal, and county. A few national museums are directly managed under a branch of the central government. Local museums (municipal and county) are managed under the local economic development plans implemented by local governments. As a consequence, cultural actions are carried out by various overlapping public actors and are coordinated and carried out jointly, in a complex contractual framework, with variations in the intensity and promptitude of local responses to central government policy guidelines.

Museums are often built as part of major infrastructure investments in urban areas that typically also include other cultural facilities (libraries, theaters, cultural centers, etc.), tourism infrastructure, and can fall within a broader project of urban rejuvenation and restoration of historical and archeological sites. Such city development projects typically involve an agreement, between a local government and a set of developers, which grants prime land in exchange for building urban infrastructure in addition to for-profit housing and commercial space. The cost of the public infrastructure is financed by the commercial value of the non-public components of the project. In 1998, the State Administration of Cultural Heritage (SACH) was established as the branch of MCT responsible to overview museum management. In the following years, SACH issued regulations to help: (a) manage and regulate the definition, function, and social responsibilities of museums (including exhibition and service obligations), (b) define and classify museum relics, (c) establish new museums, (d) distribute government subsidies and tax treatments, based on systematic evaluations and classifications of museums.

A major change has occurred with the introduction of free general admission around the middle of our sample period, although museums could continue to charge fees for seasonal and temporary exhibitions, and art performances and other museum services. Experimentation with free general admission started around 2003 with pilot trials in Hangzhou city, and Guangdong and Hubei provinces (Qin, 2008). In 2006, museums were encouraged to offer free admission, and in 2008, the Chinese government issued the 'Notice on the Free Opening of the National Museum and Memorial' that formally required public museums administered by SACH to offer free general admission. This sudden policy change offers a unique source of variation to estimate the price elasticity of demand.

2.2 Museum studies

Researchers from multiple disciplines have studied museum participation using a variety of methodologies including surveys (Kirchberg, 1998), contingent valuation (Munley, 2018), interviews and focus groups (Evrard & Krebs, 2018), museum visit data (Babbidge, 2018; Hansen, 2018), and simulations (Darnell and Johnson2001). The various topics covered in the literature are reviewed in Macdonald (2011), Frey and Meier (2006), Hooper-Greenhill (2011) and Fernandez-Blanco and Prieto-Rodriguez

(2020).[3] To our knowledge, Luksetich and Partridge (1997) is the only study that uses actual attendance data and an econometric approach to estimate museum demand. A novel aspect of our dataset is that we have a provincial panel over 20 years and we observe attendance for all museums within a province rather than a selected set of museums. This in part addresses Fernandez-Blanco and Prieto-Rodriguez (2020) validity concern, arising with survey studies, that 'in many cases, data on the entire population are not available, and only a sample of museum visitors is available.'

A modeling challenge in estimating the demand to a cultural activity is whether to use a reduced form demand equation, as done by Luksetich and Partridge (1997) for museums and Toma and Meads (2007) for symphonies, or multiple equations where demand and supply variables are determined simultaneously with possible lags between museum financing, supply investments, and demand responses (Seaman, 2006).[4] One must be careful with endogeneity bias under a reduced form approach. As argued in the introduction, however, the vast majority of Chinese museums are public, and the main supply changes were initiated through national policy directives, that were rolled out at the provincial and local levels, with implementation delays and variations in application across provinces, that generate a rich source of exogenous variations in the supply variables.

We follow Luksetich and Partridge's steps, and the broader literature on cultural participation, in that we adopt a standard demand framework, using similar explanatory variables as those commonly used, and apply it to the specific case of museum visits. The literature has emphasized the role of education and economic status under the broadly defined elitism hypothesis (Seaman, 2006). Our work includes income and education as explanatory variables, but shows that these variables do not play a major role in explaining the China museum visit boom. Instead, supply factors have played a dominant role in China during our sample period. Consistent with the museum literature, we find that museum quality plays an important impact on visits (Luksetich & Partridge, 1997) and that the museum demand is inelastic (Fernandez-Blanco & Prieto-Rodriguez, 2020).[5]

Whether museums should adopt free admission, charge a fee, or price discriminate, has been the object of much controversy in the literature (Anderson, 1998; Johnson & Thomas, 1998), and although it is a widely accepted practice to treat museums as economic agents, studies have considered a variety of arguments and museum objective functions to discuss the optimal financing of museums, through admission fees, donations, or grants (Frey & Meier, 2006).[6] A novel aspect of this work is to analyze the problem of allocating an exogenously given budget, between subsidizing admission and increasing

[3] The literature documents the socioeconomics determinants of the private demand for museum attendance and, more broadly, investigates various dimensions of museum participation (e.g., online versus physical attendance, repeat visit, local or tourist demand).

[4] In a symphony application, for example, Luksetich and Lange (1995) assume that visit is determined by donation and management decisions (e.g., quality) where these two variables are endogenous.

[5] Prieto-Rodríguez et al. (2006) estimate the demand for a wide set of cultural products, including museums, and find an elastic relation.

[6] Bailey et al 1997 study the impact of admission charges in the UK in 1997 but cannot reach a conclusion: 'It is unclear whether, and to what extent, the introduction of charges affects the total number of visitors, their social composition or their propensity to return.'

museum space or quality, and to apply this analysis to explain the growth in Chinese museum visits. The demand approach and allocation problem are discussed next.

2.3 Theoretical framework

Assume the demand for museums depends on admission fee, p_a, museum characteristic vector (e,s) which includes museum quality and museum space, and demand characteristic vector X, which includes population, income, and education. We have

$$V = V\left(p_a;e, s, X\right)$$

Further assume that the function V belongs to the Cobb–Douglas family, $V = p_a^{\alpha_p} e^{\alpha_e} s^{\alpha_s} \prod_{x \in X} x^{\alpha_x}$, where the coefficients α_p, α_e, α_s, and α_x are elasticities. The function V and its argument have well-defined empirical counterparts since visits, admission fee, space, and demand characteristics are observed, and we will follow the literature in using museum expenditure as an indicator for museum quality (Luksetich & Partridge, 1997).

2.4 Decomposition of the China museum visit boom

We evaluate the contribution of variables (p,e,s,X) to the China museum boom. To do so, we decompose the growth in museum visits between demand and supply factors. Say the researcher observes all variables at time 0 and 1. The Cobb–Douglas functional form implies.

$$\ln\left(V^1/V^0\right) = \alpha_p \ln\left(p_s^1/p_s^0\right) + \alpha_e \ln\left(e^1/e^0\right) + \alpha_s \ln\left(s^1/s^0\right) + \sum_{x \in X} \alpha_x \ln\left(x^1/x^0\right),$$

and dividing both sides by the growth rate in visits, $\ln\left(V^1/V^0\right)$, we define the normalized estimated effect of explanatory factor y to the growth of visits between time 0 and time 1 as,

$$\mathrm{NEE}(y)_{0,1} = \alpha_y \frac{\ln\left(y^1/y^0\right)}{\ln\left(V^1/V^0\right)} \tag{1}$$

$\mathrm{NEE}(y)_{0,1}$ measures the contribution of factor y to the growth in museum visits between time 0 and time 1, keeping in mind that this contribution can be negative, and this will happen when the variation in factor y predicts a change in visits that is opposite to the observed one.

2.5 Supply analysis: trading-off admission revenue, museum quality, and museum space[7]

To analyze the museum supply decisions, we follow the literature in that we assume that museums optimize an objective function. Since private museums represent a

[7] Derivations are reported in Online Appendix.

small fraction of all Chinese museums throughout our sample period, we assume that central, provincial, and local governments are the main suppliers in China. The next step is to define the museums' objective function. One way to proceed is to adopt a standard welfare criteria, use the demand function V to compute consumer surplus, and add museum profits, with the shortcoming that doing so fails to capture broader societal benefits of museums (Fernandez-Blanco & Prieto-Rodriguez, 2020). Instead, the literature has used museums' objective functions that include visits, museum quality, and other arguments. Since China has a stated policy of making museums widely available to Chinese people for the sake of educating and shaping its citizens' moral values,[8] we assume that the government cares primarily about museum visits, keeping in mind that this is a workable starting point, and the analysis could be extended to other objectives. The point of this section, therefore, is to establish benchmark predictions that are useful to interpret the government's choice of supply variables, and to investigate whether these choices can be rationalized under a simple objective function.

A museum allocates a fixed budget B between museum quality and museum space to maximize visits. Without loss of generality, we normalize the price of museum quality to one. The museum sets $e \geq 0$, $s \geq 0$, and $p_a \geq 0$ to maximize V subject to budget constraint

$$e + p_s s \leq B + p_a V$$

where $p_a V$ stands for total admission revenue and p_s stands for the cost of acquiring and building museums. Since p_s has to be paid each year, it corresponds to the leasing cost of museum space although one could annualize this leasing cost to obtain a capital market value. We do not observe p_s but will use instead the model to make inference about its value.

Increasing expenditure or museum space pays in part for itself, because doing so increases admission revenues, which in turn expands the budget set. The strength of this effect divides the parameter space into two regions: When $-\alpha_p > Min(\alpha_e, \alpha_s)$, this effect is not strong enough and the visit maximization problem has an interior solution. The first-order condition implies that the optimal admission fee is such that the ratio of museum quality to admission revenue should be equal to the ratio of corresponding elasticities, $\frac{e}{p_a V} = \frac{\alpha_e}{-\alpha_p}$, and the same holds for museum space.[9] The admission fee is not set to zero because museum quality and space are variable costs.

The second case, which occurs when condition $-\alpha_p > Min(\alpha_e, \alpha_s)$ does not hold, is the relevant case in our application since both inequalities will be rejected. There is no p_a interior solution. Instead, museum visits increase as p_a approaches zero or infinity. A decrease in museum fee increases visits when

$$\frac{e}{p_a V} > \frac{\alpha_e}{-\alpha_p} \tag{2}$$

[8] http://www.china.com.cn/policy/txt/2008-02/08/content_9661602.htm.

[9] The first-order condition also implies a trade-off between museum quality and museum space which is discussed in Eq. (3).

and it increases visits when the opposite inequality holds. An implication is that museums should decrease the admission fee when inequality (2) holds. This model delivers a different rationale for zero admission fee than the one based on a fixed cost argument found in the literature (Fernandez-Blanco & Prieto-Rodriguez, 2020). Here, the admission fee approaches zero because decreasing quality has a smaller negative impact on visit than the positive impact that is obtained from the reduction in fee, and this is true only when Eq. (2) holds.[10]

The model also implies an optimal trade-off between museum quality and space. This trade-off has a well-defined meaning when condition $-\alpha_p > \mathrm{Min}(\alpha_e, \alpha_s)$ holds, or if one assumes that p_{a} is exogenously given, as we will assume in the rest of this discussion. Taking p_{a} as given, the museum maximizes the sub-optimization problem in (e,s) and this problem has an interior solution when $\alpha_e, \alpha_s \in (0,1)$, which holds in our application. The two first-order conditions cannot be tested directly because we do not observe the price of museum space p_s. Instead, we use these conditions to infer the implied cost of museum space that rationalizes the museum's trade-off between museum space and expenditure.

$$p_s = \frac{\alpha_s}{\alpha_e} \frac{e}{s} \tag{3}$$

Equation (3) also has a dynamic rendition. Say the museum budget B increases over time, we obtain, $1 + r_{p_s} = \frac{1+r_e}{1+r_s}$ on the optimal path, where r_x stands for the growth rate of variable x. This links the growth rate of the shadow cost of museum space and the growth rate of expenditure and museum space.

3 Data, stylized facts, and empirical framework

3.1 Data

Our main source of information is the Statistical Yearbook of Cultural Relics of China (1997-2016)(SYCRC) which is published by MCT. We complement this dataset with information on GDP, urban annual per capita disposable income, population and inflation from the China Statistical Yearbook, and education from the China Population & Employment Statistics Yearbook. For detailed information about the SYCRC dataset, we refer the reader to Online Data Appendix. Each yearbook collects information about many aspects of cultural supply, participation, and consumption in China. The information covers libraries, cultural centers, performing arts, cultural heritage (including museums), for-profit cultural industries, cultural education, and so on. Some of the variables are broken down for the 31 Chinese Provinces,

[10] The other inequality, similar to Eq. (2), but involving museum space is omitted because it cannot be tested without information about p_s.

but we had to drop Beijing, Hainan, and Tibet.[11] We extracted the information pertinent to museums, starting in 1996 and ending in 2015. Table 1 presents summary statistics for the main variables computed across the 20 years and 28 provinces.

SYCRC contains information on museum count, size, expenditure, admission fees, and visits. Expenditure includes only the cost of managing museums (staff salaries, administration costs, expenses required to organize exhibits and maintain collections, educational and training activities, and so on). Following Frey and Meier (2006) and Luksetich and Partridge (1997), we use expenditure as a proxy of museum quality. The admission fee is computed as admission revenue divided by visits and measures the provincial average cost to visit a museum. In addition, we have collected information at the province level about urban population, average urban income, and education measured as the percentage of the population with a college degree. All monetary variables (expenditure, admission fee, and income) are measured in real value, that is, nominal value adjusted for inflation.

Although the SYCRC data contains information about yearly expenditure, it does not contain any information about land opportunity cost and building cost. Recall from Sect. 2–1 that museums are a part of broader deals, which rarely involve open transactions in the form of a procurement auction, for example, and it would be difficult to put a market value on the land and building cost of a new museum. This is unfortunate given that much of the CMB is about cultural infrastructure investment. In the absence of transaction data, we will use Eq. (3) to compute an implied cost of museum space under the assumption that the government allocates budgets between museum space and expenditure to maximize visits.

3.2 Stylized facts: the China museum supply boom

Table 1 reports summary statistics for the eight variables. The first part reports variables in level, the second in first difference of natural logarithm and the last column reports the average national growth rate over our sample period. Figures 1–3 plot the main variables during our sample period. Figure 1 shows that national museum visits were stable until 2003, increased a little in 2004, and shot up in 2007. National museum visits have increased at the staggering average rate of 12.6 % per year. The lower part of the figure plots the time series of visits broken down for the 28 provinces in our sample. Most provinces experience a sharp increase toward the second part of the sample period. That being said, there is much variation across provinces in the level of visits and in the year when visits start to increase and its growth rate.

Figure 2 plots the time series of the four supply variables. Museum count, size, and expenditure have all increased significantly during our sample period. The average growth rate of count is 6.3%, museum space has increased by about 10% and expenditure by 15.8 percent. This implies that the number of museums has more than doubled, total museum space has quintupled, and total expenditure has increased by a factor of fifteen. Zhang and Courty (2020) identify a break in 2008

[11] Beijing hosts several national museums with unusually high visit counts and a large share of foreign visitors. Hainan has outlier values for visits and missing values for admission fee. Tibet also has many missing observations.

Table 1 Panel summary statistics (28 provinces and 20 years)

Variable	Level					First difference of log value					National growth rate (%)[b]
	Mean	p25	p75	sd	N	Mean	p25	p75	sd	N	
Visits (10^6 people)	8.95	1.47	10.92	11.75	560	0.14	− 0.06	0.33	0.61	532	12.55
Count	71	30	91	53.24	560	0.07	0	0.09	0.13	532	6.28
Space (10^3 m^2)	278.6	102	357.6	288.05	560	0.1	0	0.18	0.26	532	10.08
Admission fee (RMB)	4.27	0.73	5.73	5.44	537	− 0.05	− 0.38	0.35	1.16	507	− 3.53
Expenditure (10^6 RMB)	153.85	24.95	201.75	202.06	560	0.17	0.04	0.29	0.24	532	15.81
Urban income (10^3 RMB)	10.79	6.18	14.42	5.79	560	0.08	0.06	0.1	0.05	532	7.78
Urban population (10^6 people)	19.75	10.66	25.48	12.89	531	0.04	0.02	0.05	0.13	502	5.01
Education (percentage)[a]	7.04	3.68	9.21	4.62	559	0.58	− 0.13	1.2	1.24	531	9.87

[a]Education is the percentage of provincial population with a college degree

[b]The last column reports the average (across years) of the national growth rate

in the growth rate of museum count, space, and expenditure which is noticeable in Fig. 2. About two-thirds of the increase in museum expenditure and space after 2008 cannot be explained by GDP. They conclude that the sample period has seen the opening of many small, low budget, and locally managed museums and an increase in the average size and expenditure of all museums. Most importantly, there are

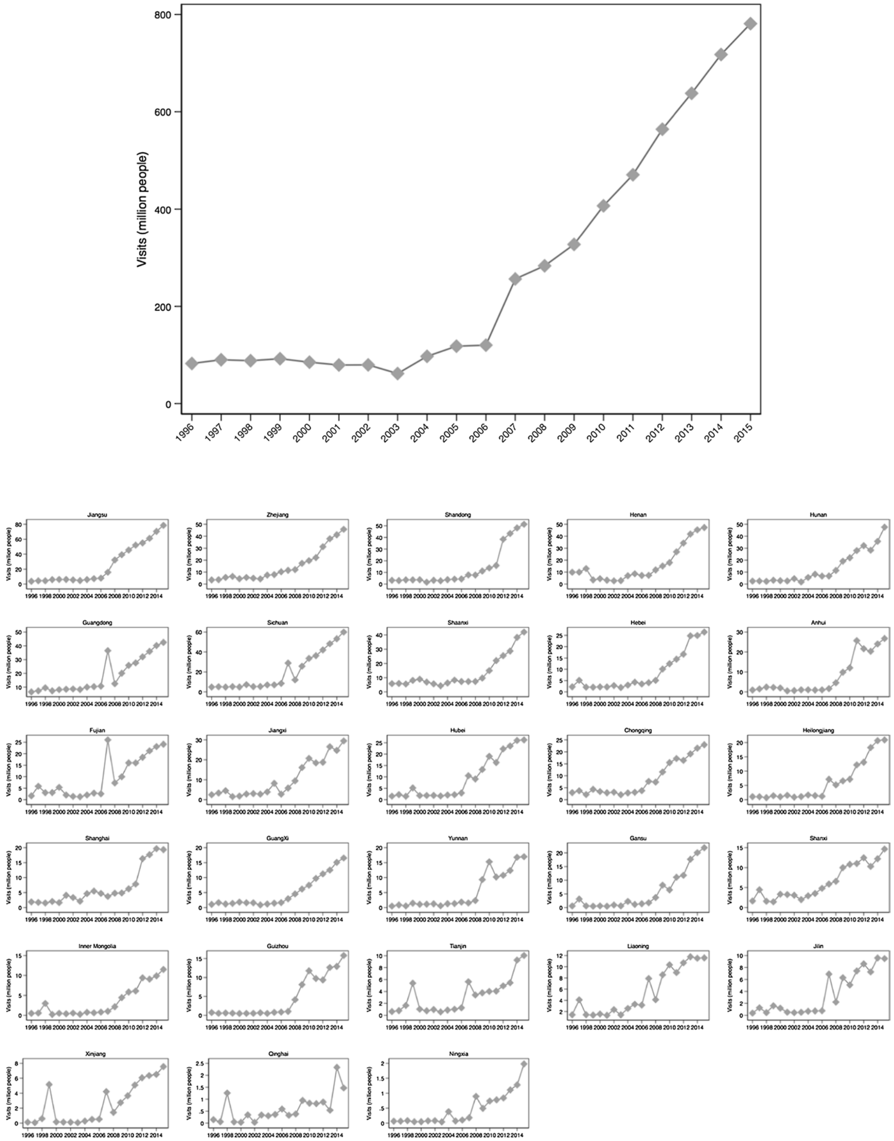

Fig. 1 National and panel visits per year. Same panels as above but presented differently (select the one that is easiest to read)

Same panels as above but presented differently (select the one that is easiest to read)

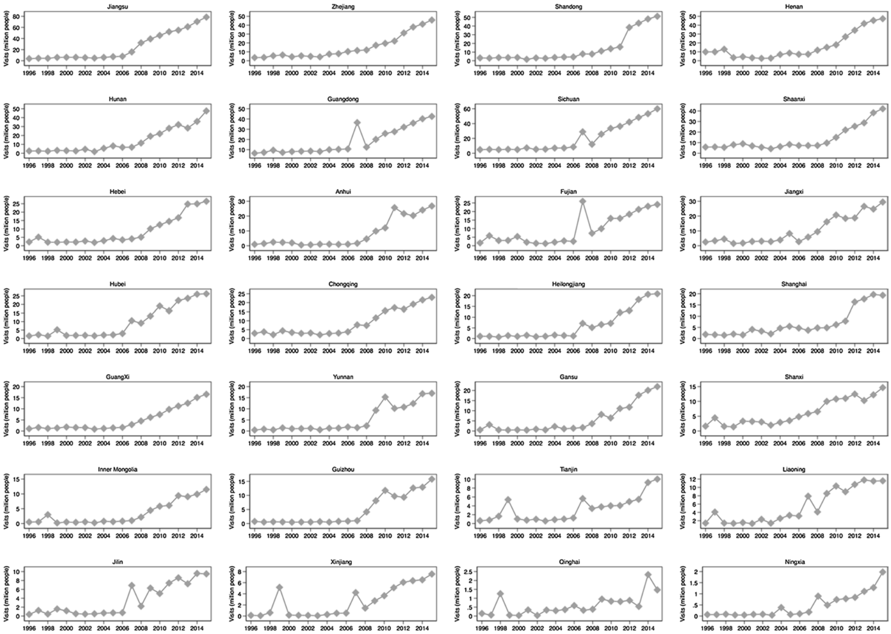

Fig. 1 (continued)

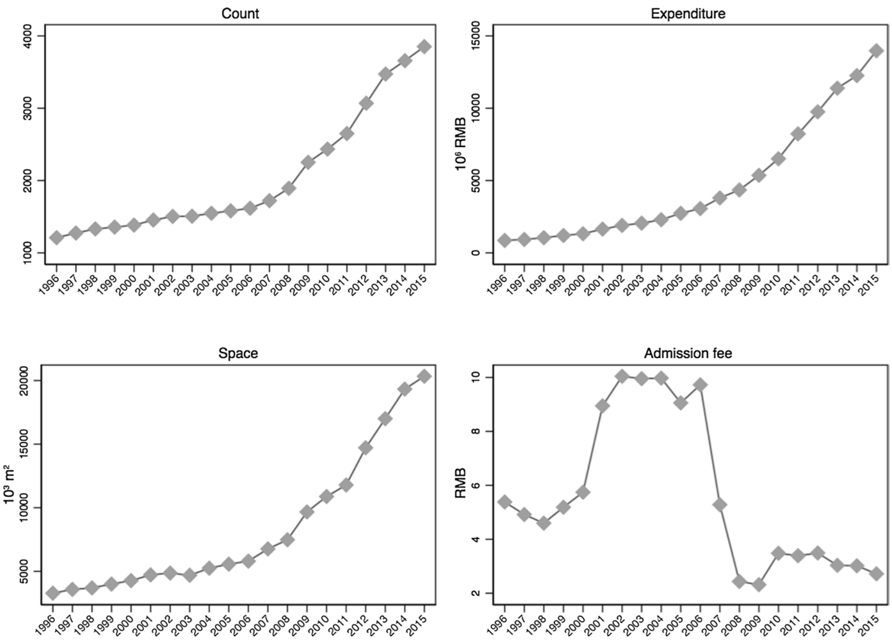

Fig. 2 National count, space, expenditure, and admission fee per year

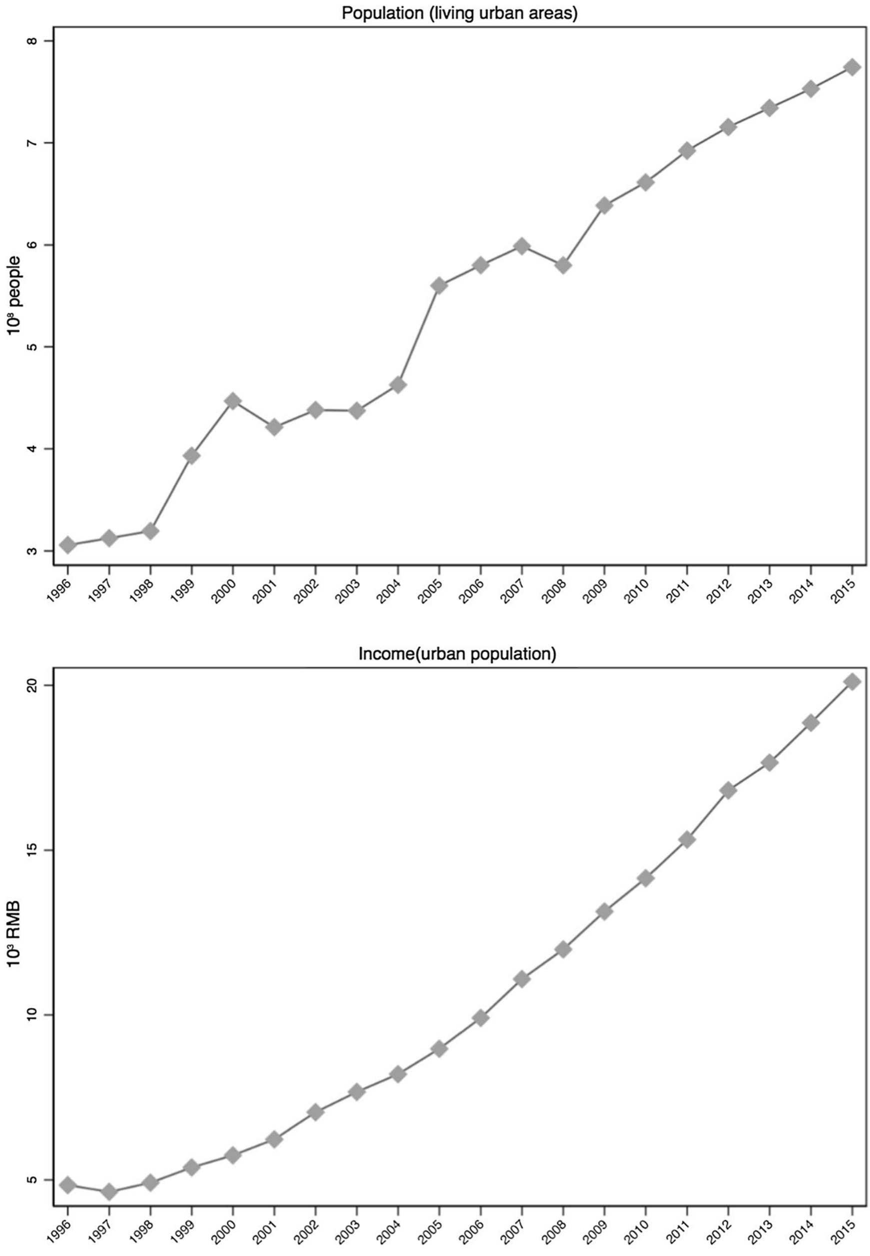

Fig. 3 National urban population and income per year

important variations across provinces in the level and timing of the increase in the supply variables.

Admission fee is the exception. It has decreased at an average rate of 3.5% per year during the sample period, but this average hides an increase during the first

10 years and a sharp decrease in 2008. The sharp drop in 2008 was driven by the mandated free general admission policy discussed earlier. The average admission fee continues to be positive after 2008 because public museums price discriminate (charge fees for non-general admission). Unfortunately, the data pools all visits together and it is not possible to decompose free general admission from paid visits.[12]

Figure 3 plots the time series of urban income and urban population during the sample period. Urban population has increased at an average rate of 5%, and this is largely due to migration toward urban centers. The average income in urban centers has increased at a rate of 7.8%. Finally, the percentage of the population with a college degree has increased at a rate of almost 10%.

Visit is correlated with the expected sign with all variables, and this holds when variables are measured in level and as first difference of the natural logarithm (see Table A1 in Online Appendix). In the latter case, the correlations are not picking up commonalities between variables in trend or exponential growth. The correlation with visit is statistically significant for all variables but income and college education. The three supply side variables are correlated, and the correlation is statistically significant, with one another. Museum count has the highest correlation with the other two variables. The other four variables (admission fee, urban population, income, and college education) do not have statistically significant correlation with any of the other explanatory variables.

3.3 Econometric model

Since museum visits have grown exponentially during our sample period (see Fig. 1), we use the natural logarithm of museum visits, denoted by $V_{i,t}$, where i denotes Chinese provinces ($N=28$) and t denotes years ($T=19$). All independent variables but admission fee have also increased exponentially over time (see Figs. 2 and 3). We take the logarithm of all explanatory variables and interpret the coefficient estimates as elasticities. To keep notations in the econometric models simple, we often omit the logarithm qualifier when we refer to these variables.

There are several challenges in estimating demand. To start, Online Appendix shows that some of the (logarithm) variables are not stationary. We tested for unit root in panel dataset using four different tests with one lag: (1) Levin, Lin and Chu test, (2) Breitung test, (3) Im, Perasan and Shin test, and (4) Fisher test for panel unit root using an augmented Dickey–Fuller test. We conducted these unit root tests for the variables in level and first difference. At least one test rejects the absence of unit root for all variables, and all four tests reject the absence of unit root for visits and for the three supply variables. When we take first difference of the logarithm value, we reject all four unit root tests for all variables.

To account for the non-stationarity, we start by estimating a first difference (FD) model:

[12] Private museums can also charge an admission fee for regular admission but these museums represent only 10 percent of all museums in 2015.

$$\Delta \ln V_{i,t} = \beta \Delta X_{i,t} + \text{Year}_t + \text{Province}_i + \epsilon_{i,t} \tag{4}$$

where $X_{i,t}$ denotes control variables, $Year_t$ are year fixed effects, Province_i are province fixed effects, and $\epsilon_{i,t}$ is an error term. Equation (4) is the empirical counterpart to the visit function $V()$ defined in Sect. 2.3, after taking the first difference of log values, and the coefficients β and the empirical counterparts of the parameters α. The control variables cover the main independent variables used in the literature. Frey and Meier (2006, Sect. 2.1) and Luksetich and Partridge (1997) recommend including admission fee, income (as a proxy for opportunity cost of time), price of alternative activities, and the value of museum collection. These broad categories are fairly well covered by our seven variables. Finally, demographic changes in urban population and socioeconomic changes in income and education are standard demand shifters that are assumed exogenous in demand studies.

Zhang and Courty (2020) show that provinces and local governments implement the same set of national policies at different pace and with varying intensity. This generates provincial variations in the supply variables, which are assumed to be exogenous conditional on year and province fixed effects. One concern in estimating demand is that there could be omitted variables that are correlated with one or several of our seven explanatory variables. This would influence the interpretation of the estimated coefficients, and the best we can do to mitigate this issue is to include the variables that have been used in the literature on cultural participation. Another endogeneity concern is that the admission fee is as an average price that uses visit shares as weights.[13] Unfortunately, this is the only information about museum fee in SYCRC. That being said, this is not a source of endogeneity as long as, for example, visit shares do not vary over time within a province.

There are several limitations with the first difference model. To start, the error term may not be stationary because museum visits may display inertia and may respond to policy or demographic changes with a lag. For example, museum visits may respond differently to a change in admission fee in the short and long run. Another limitation is that the above model imposes homogenous slope coefficients across provinces. It is possible, however, that the demand relation differs in the eastern and western provinces because these two sets of provinces have been on different economic growth trajectories in the past 30 years. To address these concerns, we use the autoregressive distributed lag (ARDL) panel model, which offer a flexible way to capture short-run dynamics around a long-run equilibrium as well as heterogeneous slope across panels. As commonly done in the literature, we start with a 'one lag' dynamic panel version, which is denoted ARDL(1,1). Following the exposition in Blackburne and Frank (2007), we obtain

$$\ln V_{i,t} = \gamma_i \ln V_{i,t-1} + \beta_{0,i} + \beta_{1,i} X_{i,t} + \beta_{2,i} X_{i,t-1} + \text{Province}_i + \epsilon_{i,t} \tag{5}$$

[13] The admission fee is equal to provincial museum admission revenue divided by provincial visits and can be expressed as an average fee, $\sum_{m,a} f_{m,a} s_{m,a}$, where $f_{m,a}$ is the fee paid in museum m for admission ticket a and $s_{m,a}$ is the corresponding share of total visits.

where the coefficient estimates may be panel specific or not, as will be discussed at the end of this section. This specification allows for delayed impact of the explanatory variables in the vector $X_{i,t}$ and also for a dynamic adjustment of visits. When $\gamma_i = 1$ and $\beta_{2,i} = -\beta_{1,i}$, the ARDL(1,1) boils down to the first difference panel specification presented in the previous equation.

For the error term $\epsilon_{i,t}$ to be stationary, it must be the case that the non-stationary variables be cointegrated. Cointegration implies that the variables move together. A variable cannot diverge independently, and any disequilibrium is a short-run phenomenon. We use two approaches to test for cointegration. First, we use two modified tests, Kao and Pedroni, of cointegration for panel dataset. Second, we conduct a bound test in order to ascertain the presence of a long-run relationship among variables in the ARDL(1,1). It is standard to rewrite the ARDL dynamic panel specification as an error correction model

$$\begin{aligned} \Delta \ln V_{i,t} = & \left(\gamma_i - 1\right)\left(V_{i,t-1} + \frac{1}{\gamma_i - 1}\left(\text{Year}_t + \text{Province}_i + \left(\beta_{1,i} + \beta_{2,i}\right)X_{i,t-1}\right)\right) \\ & + \beta_{1,i}\Delta X_{i,t} + \beta_{0,i} + \epsilon_{i,t} \end{aligned} \tag{6}$$

with the following interpretation: (a) $\gamma - 1$ is the error correction speed of adjustment, (b) β_1 are the short-term elasticities, and (c) $\frac{\beta_1+\beta_2}{\gamma-1}$ are the long-term elasticities. In equilibrium, we have $\Delta \ln V_{i,t} = \Delta X_{i,t} = 0$, and a one unit change in $X_{i,t}$ changes $\ln V_{i,t}$ by $\frac{\beta_1+\beta_2}{\gamma-1}$.

A panel version of an ARDL model is typically estimated using three approaches, and a Hausman test is used to select the most efficient estimator (Blackburne & Frank, 2007). The dynamic fixed effect estimator (DFE) pools all groups together, and only the intercept is allowed to differ across groups. DFE imposes the short- and long-term responses to be the same across Chinese provinces. The mean group (MG) estimator fits each group separately and evaluates the arithmetic average of all estimated coefficients. The pooled mean group (PMG) estimator does the same thing but allows the intercept, short-run coefficients, and error variances to differ across groups.

4 Results

Table 2 reports the results of the FD model and Table 3 those of the ARDL model. For FD, the full model with all control variables and province fixed effects is reported in column 1 without year FE and in column 2 with year FE. Columns 3 and 4 repeat the same without the count variable, which is eliminated because it is not significant in the full specification. Columns 5 and 6 eliminate the income and college variables because these variables are not significant in the first four columns. All statistics reject the null hypothesis of no cointegration at the one percent level (see Online Appendix Table A3). This confirms the long-run relationship between

Table 2 First difference estimates of log visits (Eq. 4)

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)
Space	0.3465***	0.2579**	0.3748***	0.2938***	0.3322***	0.2642***
	(0.0014)	(0.0139)	(0.0002)	(0.0029)	(0.0005)	(0.0048)
Count	0.1406	0.2076				
	(0.5018)	(0.3219)				
Expenditure	0.3058***	0.2476**	0.3189***	0.2642**	0.3341***	0.2772***
	(0.0045)	(0.0186)	(0.0026)	(0.0110)	(0.0014)	(0.0069)
Admission fee	− 0.2657***	− 0.2616***	− 0.2670***	− 0.2627***	− 0.2683***	− 0.2642***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Population	0.2770	0.2582	0.2688	0.2485	0.2739	0.2542
	(0.1339)	(0.1515)	(0.1447)	(0.1668)	(0.1367)	(0.1568)
Income	0.2122	0.1475	0.2118	0.1461		
	(0.6501)	(0.7597)	(0.6504)	(0.7618)		
Education	0.0186	0.0251	0.0188	0.0253		
	(0.3617)	(0.2334)	(0.3552)	(0.2308)		
Constant	− 0.0092	0.1432	− 0.0047	0.1505	0.0265	0.1895*
	(0.8594)	(0.2255)	(0.9271)	(0.2017)	(0.4048)	(0.0927)
adj. R-sq	0.256	0.329	0.257	0.329	0.256	0.328
Year fixed effect	No	Yes	No	Yes	No	Yes
Province fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Structural change						
N	476	476	476	476	477	477

Notes: 1. All variables are first difference of natural log value. 2. P-values in parentheses, * $p<0.1$, ** $p<0.05$, *** $p<0.01$

museum visits and the explanatory variables. The ARDL bound test, however, does not deliver conclusive results.[14] Columns 1, 2, and 3 in Table 3 report for the ARDL model the matching columns to 1, 3, and 5 in the FD table. Columns 3, 4, and 5 report the results from the DFE, MG, and PMG estimators on the selected set of explanatory variables. Columns 6, which will be discussed in the next subsection, estimates the model in periods 1996–2007 and 2008–2015 separately to check for structural break.

Table 3 also reports a Hausman test of PMG versus DFE and MG versus DFE (Blackburne & Frank, 2007). A rejection of the null hypothesis implies the adoption of the DFE estimator. That is, the PMG (respectively, MG) estimator is the efficient estimator under the null, while the DFE estimator is the efficient estimator under the alternative hypothesis. Both tests are rejected suggesting that DFE is preferred over MG and PMG.

The ARDL(1,1) error correcting speed of adjustment to the long-run equilibrium, $\gamma - 1$, is equal to $-$ 0.8. Recall that $\gamma = 1$ implies immediate adjustment to the long-term equilibrium. The estimated value suggests the existence of

[14] The bounds testing procedure is based on the joint F-statistic that all one-lagged variables in the error correction model are equal to zero, that is, $\gamma = 1$ and $\beta_2 = -\beta_1$ (Pesaran et al. 2001). We followed Fuinhas and Cardoso Marques 2012 and tested each panel separately using the routine of Jordan and Philips (2018). We obtained mixed results because we have at most 19 observations per panel (Narayan, 2005).

Table 3 ARDL (1,1) estimates of log visits (Eq. 6)

	(1)	(2)	(3)	(4)	(5)	(6)	
	DFE	DFE	DFE	PMG	MG	DFE	
						1996–2007	2008–2015
Long-run elasticities $\frac{\beta_1+\beta_2}{\gamma-1}$							
Space	0.4701***	0.5581***	0.5526***	0.3820***	0.6587*	0.471***	0.727***
	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0740)	(0.000)	(0.000)
Count	0.1372						
	(0.3076)						
Expenditure	0.4139***	0.4160***	0.4645***	0.5405***	0.5729**	0.540***	0.192
	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0149)	(0.000)	(0.131)
Admission fee	− 0.1688***	− 0.1676***	− 0.1636***	− 0.1896***	− 0.2899***	− 0.274***	− 0.107***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.000)	(0.000)
Population	0.2355*	0.2214*	0.1707	0.1423**	0.2519	0.063	0.062
	(0.0570)	(0.0699)	(0.1098)	(0.0109)	(0.8201)	(0.573)	(0.724)
Income	0.2043	0.2268					
	(0.3390)	(0.2920)					
Education	− 0.0227	− 0.0237					
	(0.2439)	(0.2152)					
Error correction $\gamma - 1$	− 0.8139***	− 0.8062***	− 0.8013***	− 0.6541***	− 1.0986***	− 0.727***	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0554)	
Short-run elasticities β_1							
Space	0.0143	0.0297	− 0.0015	0.1888	0.0351	0.052	-0.005
	(0.8852)	(0.7434)	(0.9863)	(0.2230)	(0.8588)	(0.572)	(0.967)
Count	0.1928						
	(0.2725)						
Expenditure	− 0.0284	− 0.0009	0.0133	0.0050	− 0.1057	0.110	− 0.011

Table 3 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	
	DFE	DFE	DFE	PMG	MG	DFE	
						1996–2007	2008–2015
	(0.7710)	(0.9928)	(0.8808)	(0.9656)	(0.6413)	(0.299)	(0.923)
Admission fee	− 0.0913***	− 0.0948***	− 0.1002***	− 0.2178***	0.0120	− 0.256***	0.023
	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.9435)	(0.000)	(0.314)
Population	0.1063	0.1051	0.1115	− 0.8425	0.6980	0.052	− 0.352
	(0.4697)	(0.4719)	(0.4389)	(0.4218)	(0.4165)	(0.691)	(0.587)
Income	− 0.3139	− 0.3126					
	(0.3982)	(0.4005)					
Education	0.0207	0.0222					
	(0.2503)	(0.2175)					
Constant	− 3.2949*	− 3.6781**	− 2.1136*	− 0.9721***	− 9.1557	− 0.811	1.697
	(0.0706)	(0.0419)	(0.0868)	(0.0000)	(0.5221)	(0.569)	(0.336)
N	477	477	477	477	477		
Hausman test:				$\chi2\ (4) = 0.11$	$\chi2\ (4) = 0.30$		
P-value				0.9986	0.9901		
Chow test						$\chi2\ (9) = 152.29$	
P-value						0	

1. All variables are first difference of natural log value. 2. *P*-values in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. 3. Estimates are computed using non-stationary heterogeneous panels (Blackburne & Frank, 2007). 4. Hausman test says that DFE is preferred over both PMG and MG under null hypothesis. 5. The Chow test is a joint test that the 9 s period coefficients are equal to zero

short-term deviations from long-term dynamic, and this confirms the conclusion that ARDL(1,1) is preferred over FD. This is due to the existence of short-term dynamic in response to a change in admission fee as we will discuss shortly.

Despite the indication of short-term dynamic, the FD and ARDL models give overall very similar results. All coefficients are correctly signed although not always statistically significant at conventional levels. Size, admission fee, and expenditure are significant in all specifications in Table 2 and in Table 3 in the case of the long-term response coefficients. There is no evidence of short-term adjustment for size and expenditure. Admission fee, however, displays both long- and short-term responses. Finally, the long-term effect of urban population is marginally significant in Table 3, columns 2 and 4.

The ARDL coefficient estimates (Table 3, column 3) suggest a long-term price elasticity around − 0.16 and short-term elasticity around − 0.1. The museum expenditure elasticity is around 0.46, museum space elasticity around 0.55, and urban population elasticity around 0.17. There is an economically small and insignificant effect of education and income. The boom in museum visits is largely explained by policy changes: expenditure, space, and admission fee. On the demand side, urban migration is the most important explanatory variable. Income and education are not statistically significant.

The estimated price elasticity is in line with past estimates from the literature. In their review of the literature, Frey and Meier (2006, p.2021) conclude that 'the demand for museum services is price inelastic' and report estimates within the range or − 0.1 to − 0.26. However, they raise the concern that 'most studies are limited to the case studies of one or two museums.' Our contribution to this literature is to compute estimates based on hundreds of millions of visits to thousands of museums. Even more importantly, we demonstrate the existence of slow short-term adjustments in addition to a long-term response to a price change.

The finding that income does not influence attendance is not inconsistent with the literature on museum attendance which has found mixed evidence for income effects. Frey and Meier (2006, p.2021) conclude that 'econometric estimates have found no clear link between income and attendance.' That being said, income and especially education have been widely studied as determinants of cultural participation, under the 'elitism hypothesis' with much empirical support. See Seaman (2006) for a review and our earlier work using Chinese survey data showing that both education and income influence cultural participation (Courty & Zhang, 2018). Finally, the finding that urban population matters, although not definitive, is important to understand the role of migration, and of the changing role of cities, in explaining museum visits. This is an issue that could be further explored in the future.

The finding of significant demand elasticity to museum size and expenditure demonstrates that museums create their own demand. Luksetich and Partridge (1997) have shown that the quality of a collection has positive impact on demand for some museum types and Frey and Meier (2006) speculate that the attractiveness of the building, amenities, congestion, and other museum variables should be taken into account in demand models. The elasticity estimates for expenditure and space are all less than one, suggesting decreasing returns in each output taken independently. These elasticities, however, sum up to a little more than one, and we cannot reject

Table 4 Average values by sub-period (first difference of log values)

Variable	$V_{1996\text{-}2007}$	$V_{2008\text{-}2015}$	$V_{1996\text{-}2015}$
Visits	0.1168	0.1820	0.1443
Space	0.0657	0.1467	0.0998
Expenditure	0.1631	0.1795	0.1700
Admission fee	0.0859	– 0.2652	– 0.0519
Population	0.0380	0.0339	0.0362

Table 5 Decomposition using the elasticities from the first difference (Eq. 4 and Table 2)

	Elasticity [a] 1996–2015	NEE 1996–2007	NEE 2008–2015	NEE 1996–2015
Space	0.264	0.149	0.213	0.183
Expenditure	0.277	0.387	0.273	0.327
Admission fee	– 0.264	– 0.194	0.385	0.095
Population	0.254	0.083	0.047	0.064

1. Elasticity (a) is from column 6 in Table 2. 2. Urban population's effect is statistically insignificant

Table 6 Decomposition using ARDL long-term elasticities (Eq. 6 and Table 3)

	Elasticity [a] 1996–2015	NEE 1996–2007	NEE 2008–2015	NEE 1996–2015
Space	0.553	0.311	0.445	0.382
Expenditure	0.465	0.649	0.459	0.548
Admission fee	– 0.164	– 0.120	0.238	0.059
Population	0.171	0.055	0.032	0.043

1. Elasticity (a) is from column 3 in Table 3. 2. Urban population's effect is statistically insignificant

the hypothesis that the sum is equal to one (*p*-value 0.77).[15] Thus, simultaneously doubling space and expenditure doubles visits. There is constant return to scale in expenditure and museum space.

4.1 Decomposition of the China museum visit boom

We evaluate the economic role played by each of the four variables that were found to be statistically significant in the previous section. While museum size, expenditure, and urban population have continuously increased during our sample period (see Figs. 2 and 3), admission fees have initially increased but dramatically

[15] Allowing for a structural break in column 6, we cannot reject constant return to scales in both periods: Sum equals 1.01 (p-value .89) in first period and .91, (p-value .41) in second period.

Table 7 Decomposition using ARDL period-specific long-term elasticities (Eq. 6 and Table 3)

Variable	1996–2007		2008–2015	
	Elasticity[a]	NEE	Elasticity[b]	NEE
	1996–2007	1996–2007	2008–2015	2008–2015
Space	0.471	0.265	0.727	0.586
Expenditure	0.540	0.754	0.192	0.189
Admission fee	− 0.274	− 0.202	− 0.107	0.156
Population	0.063	0.021	0.062	0.012

1. Elasticities (a) and (b) are from column 6 in Table 3. 2. The coefficients for urban population, and expenditure in the second period, are not statistically significant at 5 percent level

decreased during the second part of the sample period. For this reason, we break the sample period into two sub-periods corresponding to increasing and decreasing admission fees, respectively, 1996 to 2007 and 2008 to 2015. Table 4 shows that the growth rate of visits (approximated by the first difference of log visits averaged across provinces and years) is 11.7% in the first sub-period and 18.2% in the second.

The rest of the table computes the change in visit predicted by each explanatory variable and reports the result as a percentage of the change in visit as done in Eq. (1). Table 5 reports the NEE for the first difference model, and Table 6 does so for the ARDL model. Specifically, we compute for each independent variables (museum count, expenditure, admission fee, and urban population) the NEE over sample period 1996–2007 and 2008–2015 using the elasticity coefficient estimates in the case of the FD model and the long-term coefficient estimate in the case of the ARDL model. Without loss of insights, we discuss here only the ARDL results.

The four explanatory variables explain almost 90 percent of the variations in visits in the first period and more than 100% in the second. Expenditure explains most of the variations in visits: 65% in the first period and 46% in the second. Next comes museum space. It explains 31 and 45% of the change in visits in the first and second periods, respectively. Admission fee explains 12 and 24%, and finally urban population explains 6 and 3%. The increase in expenditure and space is the main driver of visit growth in each period. Although the elasticity coefficient is slightly higher for space than for expenditure, the latter has a greater overall impact on visits because expenditure has increased at almost double the rate of space.

Admission fee plays a special role due to the massive trend reversal that happened in 2008. Because the admission fee increased in the first period and decreased in the second (see Fig. 2), it has opposite effects in the two periods (− 12 and 24%) that partially cancel out. Although the decrease in admission fee plays an important role in explaining the increase in visits in the second period, it does not explain much of the change in visits over the entire period (6%).

A concern with these results is that there could have been a structural break at the end of the first period. Zhang and Courty (2020) document a structural break in all supply variables around 2008, and it is possible that a change in museum demand

Table 8 Implied museum cost per square meter and overall museum cost

	Elasticity	Units	Average	1996	2015	2015/1996
Visits	–	10^6 people	8.95	2.24	26.82	11.97
Expenditure	0.465	10^6 RMB	153.85	22.64	474.34	20.95
Space	0.553	10^3 m2	278.6	116.79	695.12	5.95
Admission fee	0.164	RMB	4.27	2.46	2.31	0.94
Admission revenue	0.196	10^6 RMB	30.17	6.7	67.79	10.12
Museum implied cost per m^2 $(\alpha_s e)/(\alpha_e s)(eq.3)$		RMB per m^2	656.73	230.54	811.53	3.52
Average museum space		m^2	3934	2780	5150	1.85
Museum implied cost		10^6 RMB	2.58	0.64	4.18	6.52

Implied costs are leasing (per year) cost of space

also took place. Column 6 in Table 3 estimates a model that allows the demand relationship to differ across periods and reports the coefficient estimates for the two sub-periods, 1996–2007 and 2008–2015, in two separate columns. We check for a structural break by conducting a joint test that the nine differences between the second and first period coefficients are zero. We reject that joint test (*p*-value 0) and conclude that we cannot reject the existence of a structural break. That being said, the coefficient estimates are fairly stable across the two periods, with the important difference that the price and expenditure elasticities are lower in the second period.[16] Most importantly, Table 7 reports the NEE computed using the period-specific coefficient estimates from Table 3, column 6. Comparing Tables 6 and 7, the main difference is that in the second period, the explanatory role of space has increased, and the role of expenditure decreased. Overall, the main conclusions regarding the contribution of the supply and demand explanatory variables to the China museum boom do not change.

4.2 Trading-off admission revenue, museum expenditure, and museum space

Table 8 reports the analysis of the supply variables (e,s,p_a) following the framework presented in Sect. 2–3. The top part of Table 8 reports the numbers featured in Eqs. (2) and (3), while the lower part investigates each equation separately. Table 8 reports the values of the variables featured in these equations (the elasticity estimates from column 3, and provincial averages values of supply variables), to check whether provinces set the supply variables to maximize visits. When relevant, we comment in the text about differences that appear when the period-specific coefficient estimates from column 6 are used instead.

[16] The decrease in price elasticity could be due of a lack of variation in admission fee after 2008 or to measurement error in the construction of the admission fee variable due to an increase in price discrimination after the introduction of free general admission.

Before starting, note that the estimated coefficients violate the condition for an interior solution since $-\alpha_p < \alpha_s$ and $-\alpha_p < \alpha_e$.[17] Thus, the visit maximization problem does not have an interior solution in admission fee. When $-\alpha_p < \alpha_e$, visits reaches a minimum—not a maximum—when the ratio of museum expenditure to admission revenue equals $\alpha_e/-\alpha_p = 2.84$.[18] Since this ratio is greater than 2.84, inequality (2) holds, and we conclude that visits increase when museums reduce admission fees. This explains why the government mandated free general admission around 2008. Finally, the observation that the elasticities for expenditure and space are close, 0.47 and 0.55, respectively, says that museums should spend about the same amount on running expenses and leasing costs.

Next, we consider changes in admission fee and expenditure. Museum subsidies have greatly increased during our sample period (which corresponds to an increase in B in the model), and the issue is how this increase in museum budgets has been allocated among the supply variables. Museum expenditure has increased by a factor of 21, while admission revenue has only increased by a factor of 10. Stated differently, the ratio of museum expenditure to admission revenue has increased from 3.4 to 7. When inequality (2) holds, which is the case throughout the sample period, this reallocation toward decreasing admission revenues in favor of expenditure is consistent with the goal of maximizing visits. Interestingly, the decrease in the relative importance of admission revenue is predicated in our framework, under a pure visit maximization objective, without having to refer to equity or progressive redistribution.

Finally, we turn to the shadow price of museum space. Equation (3) puts the average value of museum space during the sample period at 656 RMB per square meter. Given that the average area of museums was 2.78 thousand square meters in 1996 and 5.15 thousand square meters in 2015, this sets the implied leasing cost per museum at 0.64 and 4.18 million RMB, respectively, in these two years. To put these figures into perspective, the corresponding average museum expenditure was 0.54 and 3.51 million RMB in these years. Finally, the shadow price of museum space has increased by a factor of 3.52, corresponding to a yearly growth rate of 6.8%. Using instead the period-specific coefficient estimates from column 6, we obtain the values 0.47 and 13.30 million RMB for the implied leasing cost per museum, and 15.4% growth rate in the price of museum space. The two growth rate figures fall on each side of the national average growth in real estate cost of 7.4 percent (China Statistical Yearbook).

5 Discussion: How prevalent are ghost museums?

Some critics have argued that many new Chinese museums have few visitors (Shepard, 2019; The Economist, 2018; Wong, 2015). According to this argument, these so-called ghost museums, which are the outcome of vanity projects by local

[17] p-values are 0 using the coefficient estimates from FD (Table 2, column 6) and ARDL (Table 3, column 3) and by sub-period (column 6).

[18] The conclusion holds using the period-specific coefficient estimates from column 6.

politicians to impress party officials, have had little impact on cultural consumption. It is clear that some museums may be empty sometimes, but this is not the concern here. Critics of the CMB argue that a substantial fraction of Chinese museums have few visitors most of the time. Much of the evidence in support of this conjecture, however, is circumstantial and anecdotal in nature.

According to our estimates, the government's policy to increase total museum space and expenditure has successfully increased visits. Holding expenditure constant, we find that increasing museum space has a positive, significant, and large effect on demand. Adding museum space increases visits independently of expenditure. This challenges the conjecture that much of the added museum space had little impact on cultural consumption. Even more surprisingly, the additional space required to increase visits has decreased in 2015 relative to 1996. An additional 14 thousand square meters were required to increase visits by one million in 2015, instead of 28 thousand in 1996.[19] If anything, space has become a more effective way to increase visits.

This conclusion is subject to caveats. To start, it could be that the results are driven by a few superstar museums. For example, Beijing, which hosts several national superstar museums, could be responsible for a substantial share of the increase in visits. However, this is not a concern because we have deliberately excluded Beijing from our sample of provinces for the exact reason that it is an outlier.[20] Another concern is that a select number of museums in each province could have a disproportional influence on total provincial visits, with the possible consequence that other museums have few visitors. We can investigate this possibility by using a set of tables in SYCRC that break down all Chinese museums into four administrative categories: central, provincial, municipal, and county. Large superstar museum is typically central or provincial. Municipal and county museums include the bulk of the new museums that are part of the CMB. Table A4 in Online Appendix reports the visits per square meter of museum space, and per RMB expenditure, in 1996 and 2015, for each of the four museum categories. In 2015, visit count per square meter is 20% higher for central museums than for county museums. However, the share of central museum visits is only 3% of total visits. On the other hand, municipal museums have about the same visit per square meter as provincial museums. Thus, it is unlikely that the visit response to total museum space is driven by central and provincial museums. Although we cannot rule out that there could exist some heterogeneity across museums within a category, and this must be the case to explain empty museums, we conclude that this does not hold for the average museum in China.

Moreover, visit per museum square meter has increased by about 50% between 1996 and 2015. If anything, museums were more crowded at the end of the sample

[19] The required museum space in 1996, for example, is (.55*117/2.24)K (using values from Table 5), and the reduction is even more pronounced if one uses instead the period-specific elasticities from Table 3, column 6.

[20] Excluding Beijing, there are 10 national museums, which are located in 10 different provinces, typically in provincial capital cities (https://baike.baidu.com/item/中央地方共建国家级博物馆/8192553?fr=aladdin,).

period. This is not the case, however, for expenditure. Visit per expenditure has decreased by a bit less than half. This confirms that museum space has become a more effective way to increase visits than museum expenditure. Interestingly, local museums have the highest visits per expenditure ratio, about four times higher than for central museums in 2015.

6 Conclusions

The China museum visit boom is largely explained by policies that stimulated the development of museum infrastructure (museum space) and increased museum quality (museum expenditure). Interestingly, museum visits exhibit constant return to scale in response to increases in these two variables. Massive investments in museums have been coupled with a mandated free general admission policy around 2008. Growth in urban population played a small role in explaining the increase in visits. Overall, supply side variables explain most of the eightfold increase in museum visits over the 1996–2015 period. The evidence also dispels the conjecture that the CMB has generated many ghost museums in search of visitors. Instead, we find a strong demand response to an increase in museum space. The growth rate of museum expenditure and museum space is consistent with maximizing visits. Similarly, the 2008 free admission policy was the optimal government response to increase visits. Diverting museum budgets away from subsidizing visits, and toward increasing expenditure or museum space, would have reduced visits.

These results are subject to several shortcomings associated with the SYCRC data. Most importantly, all variables are aggregated at the provincial level. We have acknowledged that this raises endogeneity concerns for the admission fee variable. Moreover, SYCRC contains a restricted set of control variables to explain visits. Future research could use within province variations from disaggregated data to address these limitations, and to investigate in further depth the structural break in 2007–08.

China has recently engineered a market for culture, in which public museums play a central role as a center of gravity for urban cities, a place to promote cultural research and encourage international exchange, and as an engine to stimulate cultural industries. In earlier work, we have shown that the Chinese government used a two-pronged approach toward museum supply: open many small, low budget, and locally managed museums, and make significant investments in a few large and centrally managed superstar museums. There is a trade-off between these two strategies and their ability to stimulate cultural participation. In future research, one could study whether the government should build museums closer to where people live, by increasing the quality of superstar museums, or through other delivery methods.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10824-021-09410-x.

Acknowledgements We would like to thank Marco Cozzi and Felix Pretis for valuable suggestions.

Funding Not applicable.

Data availability Publicly available (see Online Data Appendix).

Compliance with ethical standards

Conflict of interest Not Applicable.

References

Anderson, R. G. W. (1998). Is charging economic? *Journal of Cultural Economics, 22,* 179–187.

Babbidge, A. (2018). Who's counting whom? Non-National museum attendances in the UK: Part 1. *Cultural Trends, 27*(4), 239–250.

Bailey, S., Falconer, P., Foley, M., McPherson, G., & Graham, M. (1997). Charging for admission to museums and galleries: arguments and evidence. *Museum Management and Curatorship, 16*(4), 355–369.

Blackburne, E. F., III., & Frank, M. W. (2007). Estimation of nonstationary heterogeneous panels. *The Stata Journal, 7*(2), 197–208.

Bollo, S., & Zhang, Y. (2017). Policy and impact of public museums in China: exploring new trends and challenges. *Museum International, 69*(3–4), 26–37.

Camarero, C., Garrido, M. J., & Vicente, E. (2011). How cultural organizations' size and funding influence innovation and performance: the case of museums. *Journal of Cultural Economics, 35*(4), 247–266.

Courty, P., & Zhang, F. (2018). Cultural participation in major Chinese cities. *Journal of Cultural Economics, 42*(4), 543–592.

Darnell, A. C., & Johnson, P. S. (2001). Repeat visits to attractions: a preliminary economic analysis. *Tourism management, 22*(2), 119–126.

Evrard, Y., & Krebs, A. (2018). The authenticity of the museum experience in the digital age: the case of the Louvre. *Journal of Cultural Economics, 42*(3), 353–363.

Fernandez-Blanco, V., Prieto-Rodriguez, J. (2020). Museums, in: T. Navarrete and R. Towse (eds.), Handbook of Cultural Economics (3rd edition) Edward Elgar, Cheltenham. ISBN: 978 1 78897 579 7.

Frey, B. S., & Meier, S. (2006). The economics of museums. *Handbook of the Economics of Art and Culture, 1,* 1017–1047.

Fuinhas, J. A., &, Cardoso Marques, A. (2012). Energy consumption and economic growth nexus in Portugal, Italy, Greece, Spain and Turkey: An ARDL bounds test approach (1965–2009). *Energy Economics*, 34(2), 511-517

Hansen, M. E. (2018). Analysing visits to English museums 1850–2015: a research note. *Cultural Trends, 27*(4), 296–305.

Hooper-Greenhill, E. (2011). Visitor studies. In S. Macdonald (Ed.), *A companion to museum studies* (Vol. 39, pp. 362–376). Hoboken: Wiley.

Johnson, P., & Thomas, B. (1998). The economics of museums: a research perspective. *Journal of Cultural Economics, 22*(2), 75–85.

Jordan, S., & Philips, A. Q. (2018). Cointegration testing and dynamic simulations of autoregressive distributed lag models. *The Stata Journal, 18*(4), 902–923.

Keane, M. (2000). Cultural policy in China: emerging research agendas. *International Journal of Cultural Policy, 6*(2), 243–258.

Kirchberg, V. (1998). Entrance fees as a subjective barrier to visiting museums. *Journal of Cultural Economics, 22*(1), 1–13.

Luksetich, W. A., & Lange, M. D. (1995). A simultaneous model of nonprofit symphony orchestra behavior. *Journal of cultural economics, 19*(1), 49–68.

Luksetich, W. A., & Partridge, M. D. (1997). Demand functions for museum services. *Applied Economics, 29*(12), 1553–1559.

Macdonald, S. (Ed.). (2011). *A companion to museum studies.* (Vol. 39). Hoboken: Wiley.

Munley, V. G. (2018). A contingent valuation analysis of the Galway City museum: welfare estimates for attendance in the absence of an admission fee. *The Economic and Social Review, 49*(4), 489–514.

Narayan, P. K. (2005). The saving and investment nexus for China: evidence from cointegration tests. *Applied Economics, 37,* 1979–1990.

O'Hagan, J. W. (1995). National museums: To charge or not to charge? *Journal of Cultural Economics, 19*(1), 33–47.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16,* 289–326.

Prieto-Rodriguez, J., & Fernandez-Blanco, V. (2006). Optimal pricing and grant policies for museums. *Journal of Cultural Economics, 30*(3), 169–181.

Qin, C. (2008). A survey of approaches on access to museums in China. *Museum International, 60*(1–2), 68–77.

Seaman, B. A. (2006). Empirical studies of demand for the performing arts. *Handbook of the Economics of Art and Culture, 1,* 415–472.

Shepard, W. (2019). Why China has hundreds of empty 'ghost' museums? *Forbes*, June 20th. https://www.forbes.com/sites/wadeshepard/2019/06/20/why-china-has-hundreds-of-empty-ghost-museums/#3f19dfb76f39

Statistical Yearbook of Cultural Relics of China. 中国文化文物统计年鉴 (1997–2016). Published by the Ministry of Culture and Tourism of the People's Republic of China 中华人民共和国文化和旅游部. ISBN: 978-7-5013-6331–5. Accessed in 2016. Available online at: http://tongji.oversea.cnki.net/oversea/engnavi/HomePage.aspx?id=N2018060240&name=YMKOI&floor=1

The Economist. (2018). "Mad about museums." Special report entitled 'Temples of Delight'. August 14th 2018.

Toma, M., & Meads, H. (2007). Recent evidence on the determinants of concert attendance for mid-size symphonies. *Journal of Economics and Finance, 31*(3), 412–421.

Varutti, M. (2014). *Museums in China: The politics of representation after Mao* (Vol. 13). Boydell & Brewer Ltd.

Wong, W. (2015). China's museum boom. *ArtForum*, November, 54, 3. https://www.artforum.com/print/201509/china-s-museum-boom-55523

Zhang, F., & Courty, P. (2020). The China Museum Boom: soft power and cultural nationalism. International Journal of Cultural Policy, 1–20.