Two decades of ‘Brain Drain’ in Olomouc (Czechia)
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ABSTRACT
This paper and accompanying map aim on the issue of brain drain (otherwise known as Human Capital Flight) concerning cultural and creative industries. The study is focused on the evaluation of Olomouc city, Czechia. In the case of a mid-sized city such as Olomouc, human capital flight is largely associated with cultural and creative fields, because it plays a significant part of the economy and character of the city. The ‘brain drain index’ of Czech municipalities has been calculated and visualized within the synthetic map. The study supported by a map investigated the brain drain from the local university. Moreover, four analytical side-maps which present the most important phenomena used for the Brain Drain Index calculating, and one side-map which summarizes the results of the questionnaire survey, have been visualized. The map layout is extended by description, table and a scheme which characterize the individual steps of the workflow.

1. Introduction
People have always been travelling (migrating) over greater or lesser distances and temporarily or permanently changed their places of residence. These are natural processes linked to human needs, today mainly resulting from work or study. Many motivations for these processes exist, including ‘push’ factors, which drive people from their places of residence, or ‘pull’ factors, which draw people towards another area (Halás et al., 2013). If migration involves the movement of primarily more educated groups of people, we speak of so-called brain drain, otherwise known as human capital flight. By contrast, the process of ‘brain gain’ suggests the movement of more educated or exceptional people who are attracted to a given area for various reasons, typically better employment opportunities. In the case of a mid-sized city such as Olomouc (Netek & Balun, 2014), human capital flight is largely associated with cultural and creative fields. Olomouc is a major university and student city, and therefore culture and creativity in young people forms a significant part of the economy and character of the city.

The present article provides an evaluation of the issue of brain drain in relation to cultural and creative industries. Palacký University in Olomouc has long been monitoring and analysing cultural and creative industries in the Olomouc agglomeration. The study presents the results of detailed research conducted in 2019–2020, with a focus on qualitative analysis of the local conditions and a proposal of measures for preventing human capital outflow and loss of talent and the development of conditions for retention in this area. Based primarily on both sociological and geoinformatics analyses, the research offers municipalities outputs for reducing unwanted effects and attracting human capital from the Czechia (Czech Republic) or abroad. Similar studies supported by comprehensive map analyses of the Central European region have to date not been published.

1.1. Migration of population
According to the Dictionary of Human Geography (Gregory et al., 2011), migration is defined as the residential relocation of an individual, family or group from one place to another. Samers (2017) included any (even temporary) movement of residents (commuting for work or education) or international exchange of residents in this definition. However, most definitions agree on the spatial movement of residents between locations which they naturally interact with once settled. The relationship thus established between the process of migration and the place itself is of great interest in geographical research (e.g. Hermele, 2021; Raghuram, 2009; Skeldon, 2014).

The movement of populations is caused by many factors which are independent of each other, significantly complicating the process of identifying causes and consequences. A more detailed categorization of
motivational factors in the Czech context is described by Drbohlav (1990), who identified four main categories: (a) socio-economic, political and cultural factors, (b) natural factors, (c) socio-demographic factors, and (d) other factors. Commonly and more generally, these factors are grouped according to pull and push characteristics (Halás et al., 2013):

- Pull – factors motivating immigration (economic prosperity, employment, greater quality of life, freedom, etc.)
- Push – factors motivating emigration (economic instability, unstable political situation, poor living environment, etc.)

All flow of migration changes the structure of the place of immigration to some extent, especially in a demographic sense. Most authors agree on the structure according to gender (more men migrate), education and occupation, and age of the population (mostly younger migrants of working age). The place of emigration is often affected by an opposite change in the structure of the population as a result of migration: emigration of people of younger working age raises the average age of the population at the place of emigration and lowers it at the place of immigration (Mládek, 1992). Changes in fertility and marriage rates may be described as secondary and indirect consequences of migration (Mládek, 1992).

In addition to demographic changes, economic transformation is also significant in places affected by migration (Korčák, 1969). The emigration of younger populations, especially at the international level, results in a loss of the economic resources spent raising these individuals through childhood in the area of origin. The economic change at the place of immigration depends on the educational level of the immigrants, their new jobs and their economic activities (Korčák, 1969). With university-educated individuals, the economic impact of migration at the destination is purely positive.

1.2. ‘Brain drain’ (human capital flight)

According to the Oxford Dictionary (Oxford University Press, n.d.), the concept of so-called brain drain is defined as ‘the movement of highly experienced and qualified individuals to a country where they can work in a better environment and be better financially rewarded.’ Some studies (Haque, 2006; Rapoport, 2004) discuss the term ‘Human Capital Flight’ as a formal and more neutral scientific term for the Brain Drain phenomenon. Otherwise, ‘brain drain’ is commonly widespread in a number of studies within the context of Creative Industries topic (Cervantes & Guellec, 2002). Crush and Hughes (2009) extended this definition to ‘the emigration of educated and skilled labour power or intellectuals from their native country.’ Individuals involved in the process of human capital flight are referred to as ‘highly skilled’, ‘qualified’, ‘HRST (human resources in science and technology),’ or colloquially, ‘brains’ (Kelo & Wächter, 2004). Scientists, doctors, engineers and specialists in other fields who have obtained a university degree (Krotký & Jaworsky, 2018) are considered highly qualified individuals. The term first appeared in the 1960s in connection with the migration of scientists from Great Britain to the USA and Canada (Cervantes & Guellec, 2002). Today it is mainly associated with international migration, in most cases from an economically underdeveloped country to a developed country. Human capital flight is also associated with the movement of people from rural to urban areas, where wages are frequently higher (Krotký & Jaworsky, 2018). In the Czech environment, the expression ‘brain drain’ is commonly associated with the departure of medical or IT staff to western European countries, typically Germany (Vavrečková & Baštýř, 2009). In recent years, many residents have also migrated from other sectors, mainly to larger cities, for higher earnings. The national scale of ‘brain drain’ is therefore observable. Some studies suggest that the financial aspect may not always be the main motivating factor for this type of migration (Reissová et al., 2021).

In addition to the push and pull factors of general migration, qualified persons may experience specific factors as a group. Although the factors of general migration may still have a significant role, the level of their influence on the decisions of a potential migrant varies according to their qualifications (Docquier & Sekkat, 2006). According to most domestic and foreign authors, the main push and pull factors are generally those associated with the labour market and economic factors, including higher salary levels and employment opportunities, etc. (Kelo & Wächter, 2004), whereas social security and the financial costs of living are mentioned as secondary factors. However, the subjective factors of migration, especially concerning family, cannot be discounted, even though they are difficult to detect for the purposes of migration analyses. More attractive regions are those where a potential immigrant has family and friendly ties. Statistical methods also often cite geographical distance as a principal factor, especially in relation to travel costs and distance from family and friends (Krasulja et al., 2016). The less the distance between regions, the more the general potential for migration.

In addition to general factors, the characteristics of the migrant are also an important consideration. The main factor is often age: migration frequently involves a younger portion of the population not exceeding the age of around forty years. Internationally, men represent a significant portion of migrants. For women, migration is often motivated by family reasons, i.e.
family migration (Krasulja et al., 2016). Comparing age and marital status in migrants, younger individu-
als may migrate more frequently because they are often unmarried. Docquier and Sekkat (2006) dis-
cussed the main factors associated with international human capital flight according to the effects on highly skilled and low-skilled individuals. The authors applied a Tobit regression model (taking into account factors such as gross national product, geographical distance, population density in the immigration region, unemployment rate in the immigration region, etc.) to eliminate the influence of zero and unknown values on the results of their analysis.

Cultural and creative industries (CCI) are activities based on human creativity, skill and talent (Netek, Burian, et al., 2019). CCIs are already significantly involved in the creation of state and municipal budget revenues, new job opportunities, full employment, positive economic externalities, and other multiplier effects. Despite positive effects (high quality of life, development of cultural and social life, etc.), negative phenomena lead to the loss of human capital. This is highly relevant for Olomouc as the city attracts high school graduates and ‘produces’ tertiary educated people mostly non-technically or non-hard-science oriented (except two faculties, the local university is rather oriented on humanities). In 2019–2020, research which focused on strengthening the position of creative industries within the Olomouc agglomeration provided an analysis of the current local situation and proposed measures to prevent the outflow of talent and human capital.

Before further steps, it is crucial to clarify the reasons why Olomouc (the 6th largest city in Czechia with a population of 100,000 inhabitants) has been used for a case study. The first crucial aspect resulting in a unique demographic and socio-economic situation is the critical presence of Palacký University. More than 1/3 of city inhabitants are students and teachers which both directly and indirectly affect the cultural and economical character of the city. Sec-
ondly, the combination of historical and landscape aspects (historical centre, UNESCO status, spiritual dimension, parks ring around the inner city) results in a specific city atmosphere – described as ‘genius loci’ by locals or as secret pearl by reputable guides (Baker, 2014). Finally, systematic research in creative industries has been conducted in Olomouc since 2015 (Netek, Burian, et al., 2019). Olomouc is directly threatened by several significant factors shaping the position of Olomouc city within the context of CCI: wide cultural infrastructure, insufficient relevance of educational programmes to current market needs, the marketing potential of large city centres nearby, and the attractiveness of working and living conditions in other settlements in the Czechia or abroad.

The primary aim of the study was to process both data and maps concerning labour movement within creative industries and illustrates the links between the trends in this labour market segment and the discharge of relevant fields at individual universities. The results of the present research are novel for two reasons: (i) domestic migration from Olomouc to other cities within Czechia in the context of human capital flight has not been precisely investigated, especially in relation to CCI; (ii) the research describes the spatial patterns and characteristics of spatial phenomena with a focus on map visualization. Inter-disciplinary research involving cooperation of natural sciences, humanities and pedagogical disciplines was conducted at Palacký University (UP) in Olomouc, Czechia, under the guidance of experts from the Department of Geoinformatics. The target group of migrants was selected by UP graduates, as detailed information of their movements is available from previous studies of CCI (Netek, Burian, et al., 2019). In addition, young and educated graduates in Olomouc participate particularly in the city’s unique CCI environment.

2. Methods

From an analysis of the data on the absolute numbers of immigrants and emigrants in the city of Olomouc from 1971 to 2018, the 1990s represent a period of the lowest rate of migration (Fig. 1). By contrast, the highest rates of immigration were in 1978, 1980 and 2007. A significant portion of the 2007 statistics reflects migration from abroad. After a sharp rise in emigration between 2000 and 2002, the growth trend of emigration continued and reached a maximum at the end of the observed period, i.e. in 2018. However, immigration also rose equalizing emigration in 2016. The largest gap between immigration and emigration was seen between 2001 and 2006. We, therefore, selected the period of the previous two decades, from 2001 to 2018, as the most relevant period for the analysis.

Based on the literature review (e.g. Docquier & Sekkat, 2006; Drbohlav, 1990; Kelo & Wächter, 2004) and according to the Czech labour market and workers’ mobility habits, we identified the most relevant factors (most frequently used) for the brain drain identi-
fication and monitoring. To investigate the flow of human capital from the city of Olomouc, we analysed available data in the Czechia concerning the factors that contribute to this phenomenon. These factors allowed us to monitor the long-term migration, commuting and geographical distance, and allowed to measure the potential for the movement of human capital from Olomouc to other municipalities in the Czechia. Based on an exploration of these individual factors and synthesis of the data by calculating so-
called brain drain index, we evaluated the degree of human capital flight from the city of Olomouc to other municipalities in the Czechia. For the analysis, we included eleven main factors (Table 1) which affect the migration of university graduates from the city of Olomouc.

Most of the factors are official statistical indicators (provided by official governmental organizations – Czech Statistical Office (2022a, 2022b) and Czech Radio (Boček & Cibulka, 2018)), with the exception of the geographical distance of the immigration region (other municipalities in the Czechia) from the emigration region (city of Olomouc). This is a significant factor which includes social, family, and transportation considerations (Docquier & Sekkat, 2006). For the purposes of this work, the shortest distance from the centroids of the municipalities was calculated using the Generate Origin Destination Cost Matrix tool in the ArcGIS Pro software environment. The final layout was examined by the Graphic Map Load Measuring Tool which employed an edge detection principle (Barvir and Vozenilek, 2021) to calculate the graphic map load distribution. Spatial data from Open Street Map database was used for this calculation (Netek, Brus, et al., 2019).

For the data synthesis (‘brain drain index’), we excluded municipalities which had zero immigration or emigration for the period 2001–2018 and therefore no anticipated migration to or from Olomouc. Expert assessments have preserved the data for municipalities only which exceeded 20 persons in absolute numbers of migrants. The set of all locations in the Czechia therefore contained 2494 municipalities for the final evaluation. The next step was to convert the input factors to a unified scale so that these factors could be further combined. Each factor in all the evaluated municipalities was then reclassified to a number in the range 1–10, the number 10 indicating the greatest potential of human capital flight occurring. The set of values of all factors was subsequently divided into ten intervals according to Jenks-Natural Breaks (Jenks, 1967). Some of the indicators can be treated as push and pull factors (acting against each other). However, again, since there is no grounding in the literature as regards quantitative analysis of the brain-drain in Czech municipalities (to the authors’ knowledge), we used the indicators with the same weights. Nevertheless, each criterion was reclassified accordingly in order to be included into the calculation. For the final evaluation of the degree of human capital flight from the city of Olomouc, we first considered the use of a weighted average, but it was difficult to find support in the literature for determining weights or to obtain reliable expert estimates. Synthesis was therefore performed using the arithmetic mean of all eleven reclassified factors.

3. Results

The resulting ‘brain drain index’ of Czech municipalities shows that the selected 2494 municipalities obtain values in the range 3.9–7.9. However, almost 90% of municipalities have a rate of 4.5–6, with half of the total having values of 5.1–5.7. The cities of Prague (7.9) and Brno (7.4) obtained the two highest values, which are relatively distant from the remainder of the set. Values greater than 5.7 occurred mainly for regional capitals (Prague, Brno, Plzeň, České Budějovice, Liberec and Pardubice). Some district cities/towns (e.g. Třebíč, Tábor) obtained less significant values (approx. 5.5). The municipalities of the neighbouring districts of Ústí nad Orlicí and Svitavy are
also prominently represented in this interval. The municipalities in the list below appear to attract the highest rate of human flight from the city of Olomouc:

(1) **Prague (Práha)** indicates significantly more optimistic figures than Olomouc in the examined factors, especially factors related to job opportunities. The only researched factor which reflects poorly on Prague is the cost of flats. Long-term and short-term immigration from Olomouc show higher rates than any other municipality. As the capital of the Czechia, Prague is very attractive to a highly qualified workforce, not only from its surroundings but also more distant areas of the Czechia, due to a comprehensive transport infrastructure which includes an international airport.

(2) **Brno** is the second most attractive region for immigration from Olomouc due to a combination of distance from Olomouc, quality of life, and especially employment opportunities. Brno is the second largest city in the Czechia, the distance from Olomouc being only approximately 45 min by transport.

(3) **Ústí nad Orlicí** indicates the third highest figures in influencing factors. However, these are not confirmed by migration statistics (Table 2). It can be concluded that this city has large potential for attracting migrants, especially due to a satisfactory combination of distance from Olomouc, relatively interesting job opportunities and the price of apartments.

(4) **Pilsen (Plzeň)**, despite its greater distance from Olomouc, is nearer to the other municipalities in this list. The large number of available flats and sufficient level of job opportunities in combination with a high population density and undoubtedly more intense social life associated with living in this municipality rank Pilsen in fourth place.

(5) **České Budějovice** as the fifth municipality has a similar character and parameters to Pilsen.

The results of ‘brain drain index’ can be analysed accordingly in relation to the data in Tables 2 and 3. These tables list the five municipalities with the highest rates of human flight from the city of Olomouc.

Table 2 summarizes the migration balance in absolute values, the balance of daily commuting and the distance from Olomouc. Negative values in the balances indicate migration from Olomouc, and positive values indicate migration to Olomouc. Table 3 describes the relative difference of the influencing factors of the municipality compared to the values of the city of Olomouc in percentages. Values in bold means less favourable values than in the city of Olomouc. Other values represent more favourable values for the given factor, indicating a higher attractiveness of the cities than Olomouc in terms of the given factor.

The data reveals the dominant migratory flow and daily trips from Olomouc to Prague and Brno. The higher value of migration to Pilsen is also obvious. Prague, the municipality with the highest value for the rate of human flight, has more favourable values than the city of Olomouc in all influencing factors, except for the price of flats, which is more than double in Prague. In terms of the brain drain phenomenon, the more favourable employment environment and balance of the labour market is indicative: it can

### Table 1. Input factors for data synthesis (Cibulka, Boček & 2018; Czech Statistical Office, 2022a, 2022b).

| Factor | Unit | Source | Year | Label |
|--------|------|--------|------|-------|
| Balance of long-term migration (migration saldo) | Persons per 1000 people municipality | Czech Statistical Office – Public database | 2001–2018 | LoTeMig |
| Daily commute balance* (commuting saldo) | Persons per 1000 people km | Czech Statistical Office – Census 2011 | 2011 | ComBal |
| Proportion of unemployed persons | % | Own calculations | – | GeoDist |
| Geographical distance | km | Czech Statistical Office – Public database | 2018 | UnPers |
| Population density | person/km² | Czech Statistical Office – Public database | – | TertEcon |
| Proportion of population aged 15–29 | % | Applicants / number of subjects | – | NumApart |
| Labour market balance for university graduates | Subjects | Czech Statistical Office – Public database | – | PriceApart |
| Proportion of tertiary economic entities | % | Czech Statistical Office – Public database | 2019 | PriceApart |
| Number of available flats | flat | Czech Statistical Office – Public database | 2018 | TertEcon |
| Price per square metre of flat | CZK | Czech Statistical Office – Register of Economic Subjects | – | Qol |
| Quality of life index | index | Czech Statistical Office Radio Data | 2017 | Qol |

*This is data from the 2011 national census. It is the only and most up-to-date data source available on daily commuting in Czechia.

†Factor ‘Labour market balance for university graduates’ is the standardized dataset provided by the Czech Statistical Office. It represents the share between the number of university or college (non-degree) graduates applying for jobs and the number of jobs available for university or college (non-degree) graduates.

### Table 2. Overview of migration balances (long-term and permanent) and distances from Olomouc to the selected municipalities.

| # | Municipality | Brain drain index | LoTeMig | ComBal | GeoDist |
|---|--------------|------------------|---------|--------|---------|
| 1. | Prague | 7.5 | –1916 | –165 | 211 |
| 2. | Brno | 6.8 | –205 | –190 | 64 |
| 3. | Ústí nad Orlicí | 6.7 | –7 | 3 | 74 |
| 4. | Pilsen | 6.6 | –52 | 1 | 280 |
| 5. | České Budějovice | 6.4 | –6 | 2 | 213 |
therefore be assumed that the strongest outflow from Olomouc is school graduates to Prague.

Brno is similar to Prague in terms of its relationship to Olomouc. However, compared to Olomouc, Brno has a higher value for employment of people who can be attracted to the city. As in Prague, the price of flats in Brno is higher than in Olomouc. Brno obtains the second highest value as a result of this factor in combination with shorter distance from Olomouc and significant values in migration balances.

Geographically, several regions which siphon human capital from Olomouc can be traced on the map. The main map reveals the role of geographical proximity in human capital flight from Olomouc. Because Olomouc is a university city, we can observe that graduates mostly return to larger cities in the neighbourhood of Olomouc (e.g. Prostějov) and the rest of Moravia (eastern part of Czechia). It is interesting to note the higher rate of outflow of human capital to the northern part of Moravia (Jesenik). This area is separated from Olomouc by the Jeseníky Mountains, yet Olomouc is a location which these locals seek out for its university educational facilities. This could therefore be defined as the return of graduates to their home region rather than an example of the human capital flight phenomena.

In the Bohemia region (western part of Czechia), the situation is more spatially heterogeneous. As mentioned above, the region around Ústí nad Orlicí (eastern part of Bohemia) is highly urbanized as a result of its degree of migration to the area; the territorial homogeneity of higher brain drain values is also evident here. The remainder of Bohemia, however, contains only local brain drain hotspots, especially in the larger cities on the outskirts of Bohemia. By contrast, the internal (mostly rural) area of Bohemia is not significant to Olomouc locals. With increasing distance, rural regions (see e.g. Pászto et al., 2015) are generally not affected by the human capital flight phenomenon.

### 4. Discussion and conclusions

The research provided a spatial analysis and identified the main locations with their causes of brain drain in the city of Olomouc, Czechia. The study investigated the outflow of human capital represented by graduates of the local university, which is relevant in connection with CCI. From an analysis of the available data related to the brain drain phenomena, we identified the municipalities and regions with the highest influx of human capital from Olomouc. The analysis involved a detailed examination of the input data, synthesis of relevant factors (‘brain drain index’) and final evaluation of the municipalities of the Czechia to determine the degree of human capital flight from the city of Olomouc. The municipalities of Prague, Brno, Ústí nad Orlicí, Plzeň and České Budějovice revealed the highest values of the rate of brain drain from the city of Olomouc. The distribution of brain drain in the Czechia shows that the regions in Moravia contribute the most to this phenomenon, mainly due to geographical distance, followed by Eastern Bohemia and larger settlements in the peripheral parts of Bohemia. One of the main outcomes of this research is that the brain drain index could serve as an alternative to more traditional questionnaire surveys. The index corresponds, to some extent, with the findings of Pustějovská (2020) – bottom-left side map. A questionnaire survey verified (Pustějovská, 2020) that job opportunities at the place of immigration is a highly significant motivation for migration. The questionnaire survey of approximately 900 graduates of Palacký University in Olomouc (Pustějovská, 2020) also revealed that a significant number of full-time graduates of Palacký University are currently working in the Olomouc Region, Central Bohemian Region and Prague. Except Plzeň and České Budějovice, ranked by the index in top five brain drain location, the index allowed to identify potential hot spot territories of brain drain throughout the country. As expected, Prague has the strongest effect on human capital flight from Olomouc (proven by both – the brain drain index and the questionnaire). On the contrary to the questionnaire, the index underperformed in case of Ostrava, the third largest city in Czechia. On one hand, questionnaire surveys can offer higher granularity of information on an individual (personal) level, on the other, it is almost impossible to cover greater geographical extent (e.g. whole country). In general, the index showed the capability to be applied
in any given municipality in Czechia. Since the brain drain index combines indicators available for each municipality, its transferability to any other case study is obvious and rather simple; yet still offering adequate results. Then, in combination with specialized questionnaire campaign, the index results can be refined and ‘personalized.’ This large-scale-to-small-scale approach appears to be methodologically appropriate and gives clear guidance for other practitioners in the field of human capital flight.

An important aspect of this study is the selection of factors that went into the calculation of the overall brain drain index. Unfortunately, there is currently no standard procedure for calculating the brain drain rate. Most of the existing studies tend to focus on a qualitative and descriptive approach, while in the field of quantitative assessment, only partial studies (e.g. Docquier & Sekkat, 2006) have been presented so far with limited use, often focusing mainly on international and not national brain drain. This is due to the difficulty in determining the factors that influence brain drain, but mainly to the unavailability or absence of appropriate data. The vast majority of countries currently have aggregate data on migration and commuting, but data on the structure of migrants are no longer available.

A significant limitation of the evaluation is the unavailability of key data which records the level of education of migrants in specific municipalities in the Czechia or any direct information about the employment of people in cultural and creative industries. It was therefore not possible to evaluate the skill bias indicator, and the resulting synthesis may be less accurate.

Therefore, in this study, we based the calculation of the brain drain index on a selection of factors that are most frequently mentioned in the literature as being crucial and are also available for municipalities in the Czechia, so the results are naturally influenced by this approach. It was very difficult to find support in the literature for the weights of the individual factors in the resulting synthesis. Therefore, the synthesis was chosen using the arithmetic average of all eleven factors. This may result in inaccuracy due to the equal weighting of all factors.

Despite this shortcoming, the quantitative analysis brings valuable information about the migration of population from the city of Olomouc. This information can serve a number of purposes (strategy of the municipality, new studies at the university, incentives of cultural sector, new co-working centres etc.), including the design of measures for retention of the educated population in Olomouc. Based on the synthesis of selected factors in the municipalities, an outflow of university educated persons from Olomouc to municipalities which demonstrate the highest rates of brain drain can also be expected in the future.

Software

All analytical results presented in this paper were calculated in ArcGIS Pro. Spatial data and maps were managed, processed and created in the Esri platform. Graphic components were designed in CorelDRAW software and incorporated into the final map layout.

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author [RN]. The data are not publicly available due to the licence restriction of the grant agency.

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