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Genetic distance and income difference: Evidence from changes in China's cross-strait relations☆

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ABSTRACT

Using the ending of the severance of ties between the Chinese mainland and Taiwan as a natural experiment, we show that *relative* but not absolute genetic distance from Taiwan has increased the income difference between pairs of Chinese provinces significantly.

1. Introduction

Recent studies have begun to examine the effect of genetic distance on economic variables such as economic exchange (Giuliano et al., 2006; Guiso et al., 2009) and income difference (Spolaore and Wacziarg, 2009). Spolaore and Wacziarg (2009), for instance, show that genetic distance from the United States of America – the world's technological frontier – is significantly correlated with current per capita income differences between countries even after controlling for geographic distance and other factors such as climate and resources. While Spolaore and Wacziarg (2009) suggest that enhanced communications and the sharing of ideas among the more genetically related – particularly with the world's technological frontier – is crucial for economic development, they do not provide any direct evidence to support this claim. For instance, it has been shown that the correlation between genetic distance and economic outcome is largely a spurious one; it disappears once the more specific geographic factors and transport costs are accounted for (Giuliano et al., 2006). By the same token, Spolaore and Wacziarg's (2009) finding may also be interpreted as the result of an enhanced bilateral trust-based economic exchange (Guiso et al., 2009).[1]

In the spirit of the literature just cited, this paper employs a natural experiment to verify whether the effect of genetic distance is indeed working through enhanced communication (Spolaore and Wacziarg, 2009) and economic exchanges (Guiso et al., 2009), and thus contributes to the growing literature that employs human genetic data in econometric analysis (Ashraf and Galor, 2008; Desmet et al., 2007; Giuliano et al., 2006; Guiso et al., 2009; Spolaore and Wacziarg, 2009).

Our natural experiment is derived from the changes in China's cross-strait relations — the ending of a long severance of ties in 1987 between the Chinese mainland and Taiwan. Between 1949 and 1987, a period spanning more than 30 years, trade and economic ties, which included the movement of people across the China Straits, were totally cut off; to the effect that the relative genetic distance from Taiwan to various Chinese provinces on the mainland should have no causal effect on the latter's income differences. This is because, according to Spolaore and Wacziarg's (2009) interpretation and Guiso, Sapienza and Zingales' (2009) trust-based evidence, genetic relatedness can only work as long as communication between countries is not being artificially shut off. But with the relaxation of policy in 1987 allowing the Taiwanese to visit their relatives on the mainland, provinces closer to Taiwan in genetic terms are likely to have benefited from their interactions with this economically more advanced region.[2] A comparison of the coefficients of the relative genetic distance before and after 1987 thus enables us to consistently estimate the effect of relative genetic distance on income differences

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[1] Guiso, Sapienza and Zingales (2009) show that genetic distance is negatively correlated with bilateral trust, and find that lower bilateral trust leads to less economic exchange, including trade, portfolio investment and direct investments.

[2] Although Taiwan was certainly not the world's leader in technology, it was clearly much more developed than the Chinese mainland in 1987. It is thus reasonable to assume that Taiwan led mainland China in the technology arena at that time.

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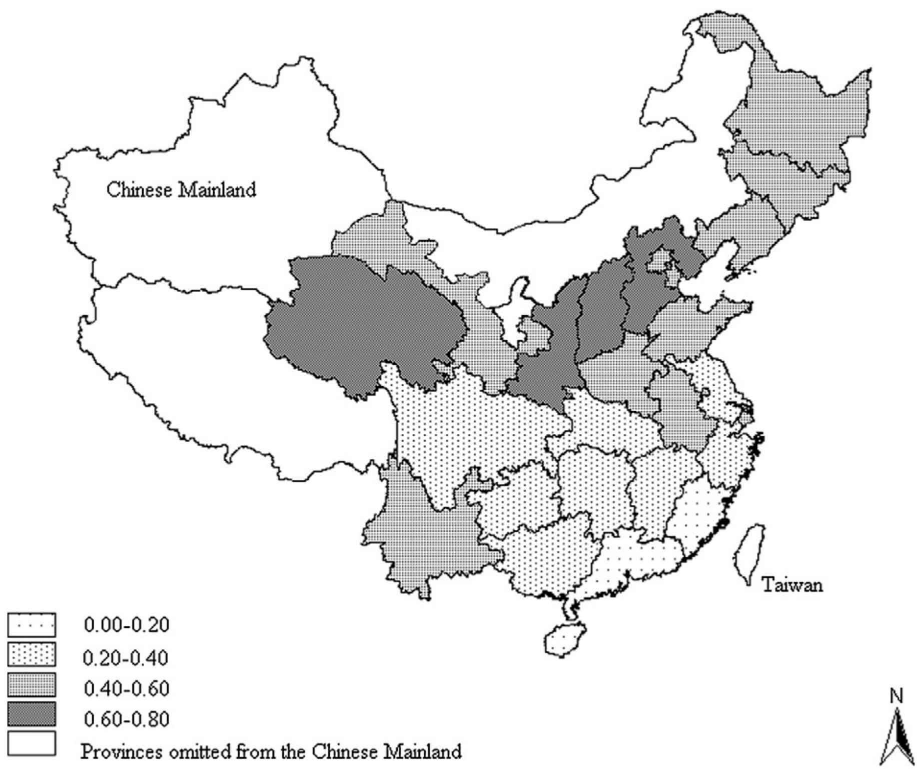

Fig. 1. The distribution of relative genetic distance to Taiwan.
Source: "CHGIS, Version 4" Cambridge: Harvard Yenching Institute, January 2007.

without worrying about the possible biases caused by any unobserved omitted variables. Indeed, our empirical results do show that the effect of relative but not absolute genetic distance from Taiwan on the income differences between pairs of provinces increased significantly after 1987.

The remainder of this paper is organized as follows. In Section 2, we introduce our data and estimation strategy. The empirical results are discussed in Section 3. Section 4 concludes our study.

2. Data and estimation strategy

Our dependent variable is the absolute difference in per capita GDP between pairs of provinces in the Chinese mainland, for example, between provinces i and j, denoted by $|\log y_i - \log y_j|$. In our sample, there are 300 such pairs (based on 25 underlying provinces, see Fig. 1)[3] from 1978 to 1994. The definition of absolute genetic distance used in this study, which measures the genetic difference between two populations in provinces i and j, is the same as that defined in Cavalli-Sforza, Menozzi, and Piazza (1994) and Spolaore and Wacziarg (2009),[4] denoted by G_{ij}^D.[5] The relative genetic distance from Taiwan is defined as $G_{ij}^R = |G_{i,Taiwan}^D - G_{j,Taiwan}^D|$. Since genetic distance is likely correlated with geographic isolation (Fig. 1),[6] we control also for the pertinent geographic factors, which include the absolute value of the difference in latitudes between provinces i and j, the absolute value of the difference in longitudes between provinces i and j, the great circle (geodesic) distance between provinces i and j (D_{ij}),[7] the contiguity between provinces i and j, and a dummy variable that indicates whether one of the paired provinces is coastal.[8] Moreover, we also control for the relative geodesic distance to Taiwan, which is (a measure of) the absolute value of the difference in the distances to Taiwan between provinces i and j, denoted by $|D_{i,Taiwan} - D_{j,Taiwan}|$.

Our empirical strategy is to regress the absolute difference in income between pairs of provinces on both relative and absolute genetic distances. We begin by specifying an equation in period zero as follows:

$$|\log y_i^0 - \log y_j^0| = \beta_0^0 + \beta_1^0 G_{ij}^R + \beta_2^0 G_{ij}^D + \beta_3^{0\prime} X_{ij} + \varepsilon_{ij}^0 \quad (1)$$

There are two justifications for taking 1978–1982 as the initial (zero) period. The first is that the Chinese mainland reformed and opened up its economy in 1978, with the "one country, two systems" policy officially adopted in 1982. The second is that the genetic distance is computed based on surveys conducted in 1982.

[3] There are 29 provinces in the Chinese mainland, but we only have the genetic distances between the ethnic Han Chinese for each province. We thus omit four provinces, which include Inner Mongolia, Xinjiang, Ningxia, and Tibet, all of which are inhabited by various ethnic minorities. The data of GDP per capita are compiled from the *Comprehensive statistical data and materials on 50 years of new China (Department of Comprehensive Statistics, National Bureau of Statistics of China, 1999) (Xin Zhongguo wu shi nian tong ji zi liao hui bian).*

[4] "The basic unit of analysis is the allele, which is a particular form taken by a gene. By sampling populations for specific genes that can take different forms, geneticists have compiled data on allele frequencies." The absolute genetic distance "takes a value equal to zero if and only if the allele distributions are identical between two populations, whereas it is positive when the allele distribution differs". A higher genetic distance "is associated with larger differences". (Spolaore and Wacziarg, 2009, pp. 480–481). Please refer to Spolaore and Wacziarg (2009) for detailed definitions.

[5] The data of G_{ij}^D can be found in "Chinese Surnames and the Genetic Differences between North and South China" (Du et al., 1992).

[6] In Fig. 1, the genetic distance from Taiwan is indicated by different patterns of shades; provinces that are geographically closer to Taiwan appear to be genetically closer to Taiwan as well.

[7] The distance of latitudes and longitudes are computed using the latitudes and longitudes of provincial capitals.

[8] The data of longitude, latitude, and coast are obtained from *"CHGIS, Version 4", Cambridge: Harvard Yenching Institute, January 2007.*

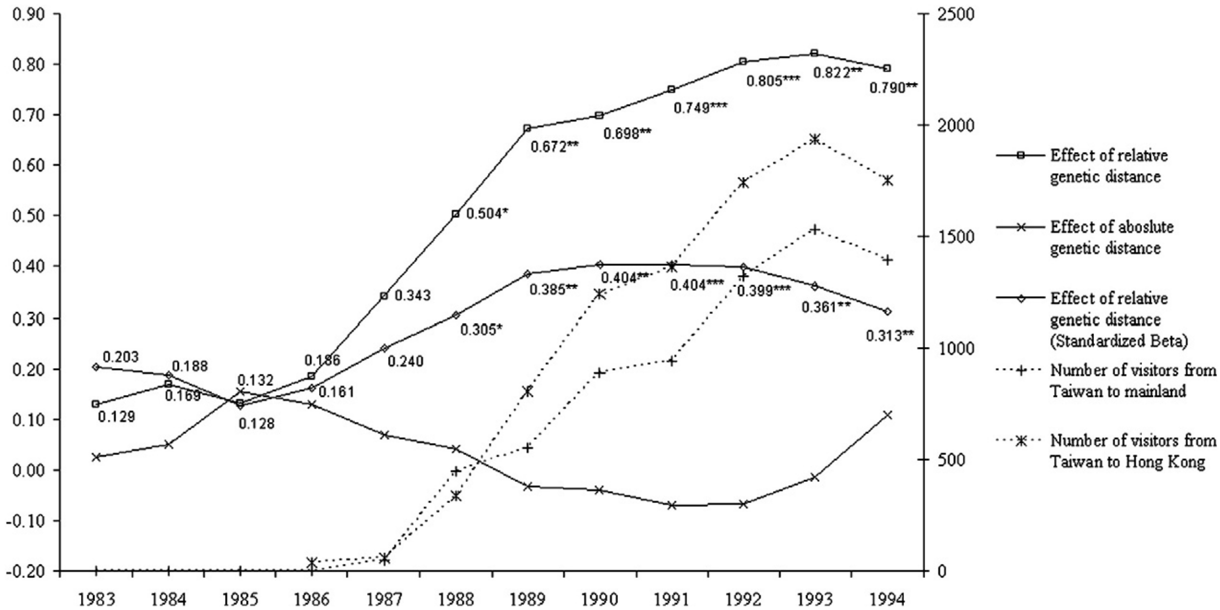

Fig. 2. Effect of genetic distance on differences in income per capita among provinces on the Chinese Mainland, by year. notes: The left axis represents the effect of absolute and relative genetic distance, whereas the right axis represents the number of visitors (in thousands); * significant at 10% level; ** significant at 5% level; *** significant at 1% level.

Given that the equations are the same every year during the 1983–1994 period, we have:

$$|\log y_i^t - \log y_j^t| = \beta_0^t + \beta_1^t G_{ij}^R + \beta_2^t G_{ij}^D + \beta_3^{t\prime} X_{ij} + \varepsilon_{ij}^t \qquad (2)$$

By taking the difference between Eqs. (2) and (1), our model specification becomes:

$$\begin{aligned}\Delta_{ij}^t &= |\log y_i^t - \log y_j^t| - |\log y_i^0 - \log y_j^0| \qquad (3)\\ &= \gamma_0^t + \gamma_1^t G_{ij}^R + \gamma_2^t G_{ij}^D + \gamma_3^{t\prime} X_{ij} + v_{ij}^t\end{aligned}$$

where γ_1^t is the main parameter representing the effect of relative genetic distance and which can be hypothesized to be significantly positive only after 1987. Following Spolaore and Wacziarg (2009), we employ the two-way clustering of standard errors as proposed by Cameron, Gelbach, and Miller (2006) to obtain robust inference.[9]

3. Empirical testing

With effect from July 28th 1987, the Taiwanese government removed the restrictions on visiting Hong Kong,[10] and from November 2nd of the same year onwards, it further allowed its people to visit relatives on the mainland. These policy changes have likely enlarged the scope of personal exchange across the Taiwan Strait. As illustrated in Fig. 2, while there were merely 47,000 such visits from Taiwan to the mainland in 1987, they increased to 1,527,000 in 1992. Thus, we can expect personal exchange to occur much more frequently in those provinces closer to Taiwan in genetic terms, as does the diffusion of technology, capital, institutions and income.

We graph the estimators of γ_1^t and γ_2^t in Fig. 2, and find that the trend of γ_1^t, which is the effect of relative genetic distance from Taiwan, is similar to that of personal exchange. First, the effects of relative genetic distance from Taiwan (γ_1^t) during 1983–1986 are insignificant, which means that the effect of relative genetic distance had no significant difference between 1983–1986 and 1978–1982, when there was no major change in cross-Strait relations. While this effect increased in 1987, it was still not significant. However, the pertinent coefficients become significantly positive after 1987, and exhibit trends similar to those of personal exchange. For example, the effect of relative distance was 0.504 in 1988, and increased to 0.822 in 1992. Expressed in terms of standardized beta, a one-standard-deviation increase in relative genetic distance increases the income difference by 0.305 standard deviations in 1988 and 0.361 in 1992, respectively.

Our estimation results would be invalid however, if there were other policy adjustments (other than the change in cross-Strait relations) affecting the relative genetic distance. For instance, the Appendix A shows that the effects of “latitudes' distance” and “longitudes' distance” do change in response to economic reforms – in particular to the open – door policy — on the mainland. What is reassuring though is that the coefficient of the absolute genetic distance (γ_2^t) remains insignificant in all 12 regressions. The different trends of γ_1^t and γ_2^t confirm our argument that the change in the effect of relative genetic distance is caused by significant changes in the cross-Strait relations but not by changes in other policies. It is worth pointing out that the effect of absolute genetic distance decreased after the Tiananmen Square incident (or the June 4th event) of 1989 and, conversely, increased with the inflows of foreign direct investment after 1992 — changes that are consistent with the idea that the absolute genetic distance is an indirect measure of the distance from the world's technological frontier (Spolaore and Wacziarg's, 2009).

4. Conclusion

Since 1949, trade and economic ties as well as the physical movement of people between Taiwan and the Chinese mainland had been banned. Given this disconnection, one would naturally expect the relative genetic distance – operating presumably via the diffusion of technology or institution – from Taiwan to have no effect on the income differences among provinces in the Chinese mainland. The ending of this cross-Strait “cold war” in 1987 has however drastically changed this situation. Indeed, by comparing the coefficients of relative genetic

[9] That is because, due to the spatial correlations of v_{ij}^t, using least squares will lead to problematic inference.

[10] Hong Kong and Macau (especially Hong Kong) were popular rendezvous for relatives from the Taiwan Straits to meet with each other before the Taiwanese government allowed its people to directly enter the Chinese mainland with effect from November 2nd 1987.

distance before and after 1987, we show that, with the removal of the restrictions previously placed upon personal exchange in 1987, the effect of relative genetic distance from Taiwan has increased, even though absolute genetic distance – which is highly correlated with the relative genetic distance from China's technological frontier – has not changed significantly. This implies that relative genetic distance affects income difference through the channel of enhanced communication and economic exchanges.

Appendix A

The effect of genetic distance, by year.

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Relative genetic distance	0.129	0.169	0.132	0.186	0.343	0.504[a]	0.672[b]	0.698[b]	0.749[c]	0.805[c]	0.822[b]	0.790[b]
	(0.094)	(0.135)	(0.170)	(0.205)	(0.251)	(0.276)	(0.274)	(0.272)	(0.275)	(0.307)	(0.350)	(0.383)
Absolute genetic distance	0.026	0.050	0.156	0.130	0.070	0.042	−0.032	−0.041	−0.071	−0.068	−0.014	0.108
	(0.083)	(0.126)	(0.150)	(0.171)	(0.201)	(0.222)	(0.225)	(0.227)	(0.230)	(0.239)	(0.255)	(0.272)
Absolute difference in latitudes	−0.001	−0.007	−0.008	−0.006	−0.006	−0.005	−0.006	−0.004	−0.006	−0.008	−0.008	−0.010
	(0.003)	(0.006)	(0.005)	(0.006)	(0.007)	(0.008)	(0.009)	(0.010)	(0.009)	(0.009)	(0.011)	(0.014)
Absolute difference in longitudes	0.003	0.000	0.005	0.007	0.013[a]	0.018[a]	0.019	0.019	0.018	0.023	0.030	0.037[a]
	(0.003)	(0.006)	(0.006)	(0.006)	(0.007)	(0.010)	(0.013)	(0.014)	(0.014)	(0.016)	(0.019)	(0.022)
Absolute geographic distance	0.051	0.224	0.072	0.023	−0.060	−0.243	−0.296	−0.426	−0.405	−0.475	−0.616	−0.747
	(0.107)	(0.195)	(0.164)	(0.159)	(0.152)	(0.281)	(0.390)	(0.434)	(0.452)	(0.468)	(0.548)	(0.673)
Relative geographic distance	−0.102[a]	−0.154[a]	−0.170[a]	−0.168	−0.197	−0.181	−0.184	−0.139	−0.116	−0.100	−0.038	0.003
	(0.059)	(0.093)	(0.095)	(0.112)	(0.129)	(0.151)	(0.165)	(0.170)	(0.168)	(0.170)	(0.194)	(0.221)
Contiguity (1 = contiguous)	0.026	0.046	0.032	0.045	0.049	0.047	0.057	0.071[a]	0.055[a]	0.053	0.051	0.049
	(0.021)	(0.028)	(0.031)	(0.035)	(0.042)	(0.043)	(0.040)	(0.037)	(0.030)	(0.035)	(0.038)	(0.038)
Coastal (1 = coastal)	−0.015	−0.007	0.003	0.000	0.012	0.013	0.008	−0.019	−0.001	0.030	0.071	0.079
	(0.021)	(0.030)	(0.026)	(0.030)	(0.040)	(0.049)	(0.051)	(0.049)	(0.057)	(0.061)	(0.064)	(0.064)
Constant	−0.058[c]	−0.076[b]	−0.061[a]	−0.075[b]	−0.100[b]	−0.105[b]	−0.115[b]	−0.095[b]	−0.070[a]	−0.082[a]	−0.103[a]	−0.120[b]
	(0.021)	(0.031)	(0.035)	(0.038)	(0.040)	(0.044)	(0.046)	(0.037)	(0.042)	(0.050)	(0.054)	(0.056)
Observations	300	300	300	300	300	300	300	300	300	300	300	300
R-squared	0.08	0.08	0.09	0.09	0.10	0.10	0.12	0.12	0.12	0.14	0.16	0.19

Notes: Coefficients are reported; Standard errors in parenthesis;
[a] Significant at 10% level.
[b] Significant at 5% level.
[c] Significant at 1% level.

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