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Has the world become more interconnected? Distance and GDP comovements over time

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ABSTRACT

It is commonly assumed that the drastic decline in trade costs over the past century has made the world more interconnected and reduced the importance of physical distance. However, empirical gravity regressions show that distance continues to play an important role in explaining trade flows. We investigate whether physical distance has also continued to affect GDP comovements between countries: that is, is it still the case that neighboring countries are more likely to have synchronized business cycles than countries further apart? We show that, while geographic distance was a significant predictor of GDP comovements between 1955–2000, this effect disappears after 2000. Thus, we find evidence for the "death of distance" when it comes to GDP comovements.

1. Introduction

It is conventional wisdom that global declines in trade barriers, shipping costs, and telecommunication costs have made the world "smaller", "flatter", and more "interconnected" than ever before (see Friedman, 2007 and Cairncross, 1997). This worldview often manifests in anecdotes about the "death of distance": that physical distance has become less important in an increasingly global market. In turn, this has led to discussions about the risks of globalization as countries become more vulnerable to economic shocks from across the globe. There is some empirical justification for this view as a well-known empirical regularity (uncovered by Frankel and Rose, 1998) is that GDP comovements are stronger among country-pairs that trade more with one another.[2] This suggests that increased globalization may have resulted in countries becoming more interconnected with more distant trading partners.

However, another well-known empirical regularity is the *distance puzzle*: that the sensitivity of bilateral trade flows to geographic distance has remained persistently high over time. This is best demonstrated by a meta-analysis conducted by Disdier and Head (2008) which finds that the negative impact of distance on trade has actually risen since 1950 and "remained persistently high ever since".[3] As Leamer and Levinsohn (1995) conclude in their survey of the literature, the persistence of distance in empirical gravity regressions suggests that, "contrary to popular impression, the world is not getting dramatically smaller".

In this paper, we consider a related question: is the world becoming "more interconnected" over time? Specifically, do we observe a diminishing impact of physical distance on GDP comovements? First, using a panel data set of 70 countries over 65 years, we show that distance is an important predictor of GDP comovement across country pairs (i.e., geographically close countries are more likely to have synchronized business cycles). Then we show that physical distance has become a less important predictor of international comovements in the past several decades. Specifically, while distance is a significant predictor of GDP comovements from 1955–1999, it is not over the 2000-20 period. Thus, the "death of distance" does appear to apply to cross-country GDP comovements.

2. Distance and cross-country comovements

To compute bilateral correlations for real economic activity, we use output-side real GDP data from the Penn

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2 A number of studies have demonstrated the robustness of this empirical regularity (e.g., see Baxter and Kouparitas, 2005 and Blonigen et al., 2014).

3 This has also been termed the *missing globalization puzzle* (see Bhavnani et al., 2002) and has led to an extensive empirical literature (e.g., see Buch et al., 2004, Carrëre and Schiff, 2005, Brun et al., 2005, Yotov, 2012, Lin and Sim, 2012 and Borchert and Yotov, 2017).

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World Table (PWT) version 10.01[4] (see Feenstra et al., 2015), transformed by taking natural logarithms and detrending via either first differences or the Hodrick–Prescott (HP) filter (with smoothing parameters of 6.25 and 100) as in Frankel and Rose (1998) and Kose and Yi (2006).[5] Over five and 10 year periods from 1955–2019, we compute the Pearson correlation coefficient of detrended log GDP between country X and country Y. Since our motivation in this paper is to estimate whether the impact of geographic distance on these GDP correlations changes over time, we restrict ourselves to balanced panels with data available for every year. This results in a broad sample of 70 countries over 13 separate time periods (from 1955–2019) for the 5-year windows and 108 countries over 6 time periods (1960–2019) for the 10-year windows. Summary statistics are provided in Appendix.

We first look at the relationship between distance and the comovements of aggregate production (GDP). This is motivated by the well known empirical regularity that such economic comovements are greater among country-pairs that trade more. This was first uncovered by Frankel and Rose (1998) and multiple subsequent empirical studies have confirmed the robustness of this empirical regularity (e.g., see Baxter and Kouparitas, 2005 and Blonigen et al., 2014).[6]

We undertake a similar analysis but our focus is on the direct effect of geographic distance on GDP comovements. Thus, we estimate the following equation:

$$Corr(\ln Y_t, \ln X_t) = \beta DIST_{xy} + \beta_2 CUL_{xy} + \beta_3 TA_{xyt} + \alpha_t + \alpha_x + \alpha_y + \epsilon_{xyt} \quad (1)$$

where the dependent variable, $Corr(\ln Y_t, lnX_t)$, is our measure of the cross-country correlation between GDP in country Y and country X. $DIST_{xy}$ represents our measures of physical distance between the two countries: the population-weighted great circle distance ($lnDistance$) between the two countries and an indicator variable ($Contiguity$) that takes the value one if the countries share a land border.[7] Note that we are estimating β primarily from cross-sectional variation (i.e., does a country have greater GDP comovements with nearby countries as opposed to more distant countries)?[8] We also include time and country fixed effects (note that observations are country-pairs, while the fixed effects are country level).

As additional control variables we include measures of cultural distance between the two countries (CUL_{xy}): an indicator variable for common language and an indicator variable for a colonial relationship. Finally, to control for additional ties between the two countries, we include an indicator variable for joint membership in a multilateral agreement (i.e., the WTO) and a regional trade agreement (RTA).

Results of this regression are provided in Table 1. Columns 1–3 use the 5-year windows (from 1955–2019) while Columns 4–6 use the 10-year windows (from 1960–2019).[9] Results are consistent with the empirical regularity that cross-country comovements are increasing with trade. Specifically, with one exception, variables that are traditionally positively correlated with trade volume (e.g., common borders, trade agreements) are correlated with increased cross-country comovements, while variables that are negatively correlated with trade volume (i.e., physical distance) are negatively correlated.

As can be seen, bilateral GDP comovements are decreasing in physical distance. The coefficient estimate on distance (using Column 3) suggests that a country-pair at the 25th percentile of distance (3000 km, or the distance from the U.S. to Costa Rica) would have a cross-country correlation coefficient 0.025 higher than countries at the 75th percentile of distance (9000 km, or the distance from the U.S. to Greece); this is 14.6% of the median correlation.

3. The changing effect of distance over time

It is clear from the results of Table 1 that bilateral GDP comovements generally weaken with distance. Has this relationship changed over time? A common assumption of globalization is that declining trade costs should result in countries expanding their ties with more distant countries, which (potentially) could result in countries becoming more interconnected with more distant partners. We divide both our 13 five-year time spans and 6 ten-year time spans into three periods: 1955–1979 (or 1960–1979),1980–1999, and 2000–2019,[10] and, in Table 2, we repeat the analysis of Table 1 allowing the coefficient estimate on distance to vary over time. Because the other coefficient estimates are essentially unchanged, we present only the marginal effects of physical distance for each time period.

Table 2 exhibits a decidedly non-monotonic pattern in the time variation. The first period,1955–1979 (or 1960–1979), exhibits results very similar in sign and magnitude to those discussed in Section 2: country-pairs that are located closer together exhibit more synchronized business cycles (i.e., higher GDP correlations). As can be seen, this relationship becomes even stronger over the 1980–99 period. However, it then reverses and the correlation between shorter physical distance and stronger business cycle synchronization essentially disappears in the final (2000-19) time period.

The main results of interest in Table 2 are the distance coefficients for the most recent period, 2000–2019. The estimated association of distance with GDP comovements has substantially decreased and remains only (weakly) statistically significant in a single specification. This does not imply that economic comovements no longer occur (in fact, they are highest on average in this period),[11] but that they are becoming less localized: on average, a country's business cycles are no more strongly correlated with a nearby country than with one more distant. This result provides some evidence that with globalization, the importance of physical distance in the modern economy has decreased.

4. Conclusion

In this paper, we use a long panel of cross-country GDP comovements to show that physical distance has become a less important predictor of business cycle synchronization since 2000. This result lends credence to conventional wisdom arguments that globalization has reduced the importance of physical distance.

This finding is also of interest since physical distance has continued to be a significant predictor of trade flows in empirical gravity regressions and de Soyres and Gaillard (2022) found that the trade-comovement link has actually strengthened over the past several decades. Thus, our results might have implications for the considerable

[4] Groningen Growth and Development Centre, 2023, "Penn World Table version 10.01", https://doi.org/10.34894/QT5BCC, DataverseNL, V1

[5] The log transformation means our measures of economic comovements are, roughly, in percentage terms which assists in addressing the issue of scale differences across countries.

[6] This link between trade and business cycle comovements has attracted attention as it has implications for the benefits of economic integration and also generated an interesting puzzle for standard business cycle models (i.e., the "trade-comovement puzzle" of Kose and Yi (2006)).

[7] As is common, we use the natural log of distance given that geographic distance tends to have a nonlinear impact on trade flows.

[8] As the distribution of the population changes over time, our $lnDistance$ measure changes, and political upheaval can affect the contiguity measure. However, time series variation in both variables is minor.

[9] The difference in observations between the first-difference and HP-filter regressions is because we are missing 1954 GDP data for 4 countries and 1959 GDP data for 35 countries.

[10] These correspond roughly to the World Economic Forum's Globalization 2.0, 3.0 and 4.0 eras.

[11] Indeed, an interested reader might wonder the extent to which the decline in the importance of distance in the post-2000 period is driven by the global financial crisis (2007–2009). As a robustness check, we ran a specification where we drop the 2005–2009 period from the analysis and continued to observe the decline in the distance coefficient for post-2000 period. Results are available on request.

Table 1
Distance and GDP correlation.

	(1) 5-year First diff	(2) 5-year $HP(100)$	(3) 5-year $HP(6.25)$	(4) 10-year First diff	(5) 10-year $HP(100)$	(6) 10-year $HP(6.25)$
Distance	−0.013**	−0.040***	−0.023***	−0.023***	−0.027***	−0.020***
	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.004)
Contiguous	0.117***	0.045*	0.080***	0.090***	0.061***	0.073***
	(0.023)	(0.027)	(0.022)	(0.023)	(0.019)	(0.017)
Common Language	−0.002	0.016	0.010	−0.007	0.008	0.012*
	(0.009)	(0.011)	(0.009)	(0.009)	(0.008)	(0.006)
Colonial Relationship	−0.005	−0.046*	−0.018	−0.017	−0.014	−0.024
	(0.021)	(0.026)	(0.021)	(0.022)	(0.020)	(0.017)
RTA	0.064***	0.076***	0.053***	0.073***	0.046***	0.053***
	(0.013)	(0.014)	(0.013)	(0.014)	(0.014)	(0.011)
WTO	0.007	−0.000	−0.003	0.042***	−0.012	−0.009
	(0.010)	(0.011)	(0.010)	(0.010)	(0.008)	(0.007)
Observations	28,730	32,292	32,292	16,200	35,304	35,304
R^2	0.080	0.065	0.075	0.138	0.058	0.086
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors clustered by country-pair in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2
Distance and GDP correlation over time.

	(1) 5-year First diff	(2) 5-year $HP(100)$	(3) 5-year $HP(6.25)$	(4) 10-year First diff	(5) 10-year $HP(100)$	(6) 10-year $HP(6.25)$
Distance	−0.015**	−0.025***	−0.021***	−0.020***	−0.016***	−0.015***
	(0.007)	(0.008)	(0.007)	(0.007)	(0.006)	(0.005)
Distance×P2	−0.005	−0.058***	−0.023***	−0.028***	−0.036***	−0.024***
	(0.008)	(0.009)	(0.008)	(0.008)	(0.007)	(0.006)
Distance×P3	0.014	0.014	0.022**	0.025***	0.005	0.013*
	(0.009)	(0.010)	(0.009)	(0.009)	(0.008)	(0.007)
Implied Distance Coefficient Estimates by Time Period						
1955/60–1979	−0.015**	−0.025***	−0.021***	−0.020***	−0.016***	−0.015***
	(0.007)	(0.008)	(0.007)	(0.007)	(0.006)	(0.005)
1980–1999	−0.020***	−0.083***	−0.044***	−0.048***	−0.052***	−0.039***
	(0.007)	(0.009)	(0.008)	(0.007)	(0.006)	(0.005)
2000–2019	−0.001	−0.011	0.001	0.005	−0.011*	−0.002
	(0.008)	(0.009)	(0.008)	(0.007)	(0.007)	(0.006)
Observations	28,730	32,292	32,292	16,200	35,304	35,304
R^2	0.080	0.067	0.076	0.141	0.059	0.087
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: P2 and P3 are indicator variables for the time periods 1980–99 and 2000–19 respectively. Regressions also include the other explanatory variables in Table 1. Standard errors clustered by country-pair in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

theoretical literature on the *trade-comovement puzzle* of Kose and Yi (2006): that, in a standard international business cycle model, trade costs alone cannot explain the strong empirical correlation between bilateral trade flows and business cycle synchronization. Since then many papers have (necessarily) moved past simple trade flows to provide alternate explanations of business cycle synchronization including financial linkages (Imbs, 2004), input–output linkages (Johnson, 2014), multinational activity (di Giovanni et al., 2018), changing trade elasticities (Drozd et al., 2021) and global value chains (de Soyres and Gaillard, 2022). Thus, our finding that bilateral distance matters less for business cycles (even as it remains a significant predictor of trade volume) can be seen as complementary to this literature.

Appendix. Supplementary information

Summary statistics for our measures of GDP correlation are provided in Table 3.

In our sample, GDP comovements have increased since 2000 (e.g., in Table 4); the mean correlation in 2000-19 is two to three times higher than the mean pre-2000 values for all three measures. This is one of the reasons we include time fixed effects in all our specifications.

Table 3
Summary statistics — measures of production comovements.

	Mean	Median	Std Dev	Min	Max	N
5-year windows						
First diff	0.122	0.165	0.516	−0.998	1.000	28,730
$HP(100)$	0.112	0.181	0.595	−1.000	1.000	32,292
$HP(6.25)$	0.119	0.171	0.544	−0.998	0.998	32,292
10-year windows						
First diff	0.128	0.138	0.379	−0.957	0.976	16,200
$HP(100)$	0.078	0.097	0.449	−0.973	0.994	35,304
$HP(6.25)$	0.084	0.093	0.386	−0.951	0.985	35,304

Data availability

Data will be made available on request.

Table 4
Measures of production comovements over time.

	First diff	$HP(100)$	$HP(6.25)$
5-year windows			
1955–1979 Mean (std. dev.)	0.072 (0.509)	0.081 (0.577)	0.076 (0.526)
1980–1999 Mean (std. dev.)	0.076 (0.517)	0.066 (0.621)	0.070 (0.551)
2000–2019 Mean (std. dev.)	0.232 (0.509)	0.198 (0.582)	0.223 (0.545)
10-year windows			
1960–1979 Mean (std. dev.)	0.067 (0.352)	0.025 (0.429)	0.037 (0.363)
1980–1999 Mean (std. dev.)	0.061 (0.376)	0.049 (0.454)	0.052 (0.380)
2000–2019 Mean (std. dev.)	0.254 (0.375)	0.161 (0.452)	0.163 (0.403)

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