Democracy and economic growth in an interdependent world

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Abstract

We develop a spatial vector autoregression framework to examine dynamics of interdependence between democratic distance among countries and their long-run growth processes. Drawing on the interface literature of international policy coordination and endogenous growth, we construct a democratic production function, the dynamics of which is examined on the cross-country growth complementarity and welfare. We focus on both geographic and relational attributes of democratic distribution and find evidence of significant dynamic spatial autocorrelation among countries' growth processes indicating the existence of high degree of complementarity. Our estimation of a convergence-pattern framework also provides new insights into the likely impact of democracy on economic growth over decades. We find that democracy has exerted persistent growth-enhancing effect since 1970 where the democratic distribution has steadily shifted locus from low-level to high-level equilibrium justifying the existence of multiple equilibria in international policy coordination literature. Finally, it is demonstrated that the relevance of geographical proximity in facilitating interdependence in economic growth is overshadowed by relational proximity represented by democratic distance. Our results hold interesting policy implications.

Key Words: International policy coordination, democratic production, economic growth interdependence, semiparametric spatial vector autoregression, growth complementarity.

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1 Introduction

Lately, research in international policy coordination and economic and political debates have stressed that an economy's growth process cannot be understood independent of the development occurring in the 'neighborhood'.[1] Due to the complex interplay of endogenous and exogenous, geographic and non-geographic factors, the source and dynamic nature of interdependence in (cross-) country growth rates do not lend to easy interpretation and modeling. However, the past two decades of research have experienced significant progress in this regard by modelling interdependence among countries' growth processes with proximate relational and/or geographic attributes. Blackburn and Ravn (1993) and Parhi and Mishra (2009) use, for instance, human capital spillovers and international diffusion of knowledge whereas Azomahou et al. (2009) introduce demographic distance among countries to study spatial dynamics of economic growth. Stressing on geography on the other hand, Bosker and Garretsen (2009) instrumentalize the role of geography of institutions in a country's economic development remarking that 'economic development is not only stimulated by improved own-country institutions but also by better institutions across regions'. The nature of relationship among countries therefore can be viewed in 'relational' rather than 'pure geographic' sense. However, geographically clustered economies may demonstrate better relational affinities than geographically disparate countries. Viewing interdependence among countries in this sense, one may argue then that 'democratic levels' working as a 'cohesive factor' among countries may stimulate positive interdependence in their growth processes.[2] Polashek (1997) has also put forward similar perspective by arguing that democratic dyads trade more than nondemocratic dyads, and exhibit less conflict and more cooperation.

Trade is one natural economic factor through which one may study the likely impact of 'closeness' between two economies. Geographical closeness is not always enough to enforce high trade and scientific exchanges. In an interdependent and highly globalized world, 'trust' among countries is an important facilitator of intense economic interaction. A measure of trust, often emphasized in political and economic forums is the level of democracy and the process of democratization a country has demonstrated over time.[3] High volume of trade and strategic

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[1] where neighborhood structure can be defined both in pure geographic (in light of the economic geography literature) and relational sense (in light of the literature of innovation and diffusion and international policy coordination).

[2] Dasgupta (2009) argues that individuals tend to interact with others in a social setting whom they implicitly 'trust' or foresee a trust value. In our case, state of democracy of a country is an indication of economic and social stability which may encourage countries to participate in investment decision and scientific collaborations.

[3] The former US Presidents Bill Clinton and George Bush often stressed in international policy discussions

scientific and economic interactions thus are argued to take place among countries which display stronger democratic or democratization power. However, despite the increasing role of relational proximity among countries while defining the nature and extent of interdependence in growth processes, the role of geography cannot be undermined. Trade costs is a primitive determinant in cross country growth. Therefore, geographically proximate countries with high democratic levels is always better for economic interaction.[4]

In view of the above the main objective of this paper is to study the nature and extent of cross-country growth interdependence which is hypothesized to be determined by 'democratic distance' among countries. The goal is to allow democratic proximity (representing cohesive factor), irrespective of geographical proximity among countries, to play instrumental role in understanding spatial economic growth interdependence. To this end, we build a testable empirical spatial vector autoregressive growth framework and study dynamic interdependence in countries' growth processes determined by democratic closeness or distance. The role of geography is also explicitly considered by sub-grouping countries with respect to their regional characters. Trade costs, as emphasized in conventional economic geography literature, is also indirectly accommodated in our model as we assume that countries sharing common borders, that is falling within a region, are likely to interact more.

Our work complements theoretical conclusions of Polashek (1997) and many others and comply with empirical implications of Bosker and Garretsen (2009), with an important exception that we find significant spatial autocorrelations among countries that vary with respect to democratic levels. Geography is also found to matter for enhancing growth interdependence, but the effect of geography in absolute sense is overshadowed by relational proximity (determined by democratic distance). Our analytical construct gives rise several interesting conclusions on growth interdependence, which to the knowledge of the authors have not been modeled or outlined in the extant literature. By modeling interdependence among countries growth processes using spatial vector autoregression and employing a non-parametric method for estimation we are able to test if countries growth processes are complementary with respect to democratic distance. Due to their well known ability to lend direct implications to policy, issue of complementarity has been receiving increasing prominence in international policy coordination literature. Moreover, we are able to test if interdependence among countries growth processes is non-linear

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that the USA will cooperate in growth programs and provide aid to those countries which are democratic or have shown significant progress in democratic values over time.

[4]Tobler's (1970) law also states that 'everything is related to everything but near things are more related than distant things'.

and whether such non-linearity is significantly explained by democratic distance.

This research is empirically focused, however, our empirical construct builds on recent theoretical literature (e.g., Blackburn and Ravn, 1993; Polashek, 1997, Mishra et al., 2011, which integrate theories from endogenous economic growth, international policy coordination and economic geography). Before we carry out interdependence analysis using the proposed democratic distance metric, we first investigate if the positive effect of democracy in economic growth has increased over years. To this end we have estimated a convergence-pattern model following on the conventional framework of Solow-Swan type but extending it by incorporating the role of human capital and democracy. Interesting results emerge: contrary to the finding of insignificant and sometimes negative effect of democracy in economic growth in recent literature, we find that democracy has exerted growth-enhancing effect over decades since 1970. The positive result is also supported by the Kernel density plots of democracy which depict a clear transition of countries in the hub-structure from low-level democratic equilibrium to high-level democratic equilibrium. In the second step, we assess the spatial effect of democracy on economic growth. A semiparametric spatial vector autoregression is estimated where countries growth processes are determined first by their own past growth and second by the 'distance' among them with respect to geographic as well as democratic levels. We find that significant spatial autocorrelations among countries exist which vary with respect to democratic levels. Geography is also found to matter for enhancing growth interdependence, but the effect of geography in absolute sense is overshadowed by relational proximity (determined by democratic distance).

The rest of the paper is structured as follows: Section 2 provides a short review of the existing literature. To motivate spatial interdependence analysis in economic growth due to democratic variation, we study in Section 3 the main results based on the estimation of a conditional convergence model of economic growth and democracy. Section 4 develops the analytical and empirical framework for studying cross-country growth interdependence and discusses estimation strategy. Section 5 is devoted to the empirical analysis from spatial VAR regression. Finally, Section 6 concludes the paper with policy implications.

2 Theory and previous empirical evidence

Recent literature has provided compelling evidence to believe that democracy is instrumental to acceleration of economic growth. According to Freedom House (2006), more than 80 countries embarked on the democratic road and between 1980 and 2000, the percentage of the world

population living under democratic rules went from just over 30 to more than 57 percent. In contradistinction, some researchers argue that too much democracy retards the growth process. In view of the conflicting debates about the real impact of democracy on growth, we summarize the main implications from the literature by classifying them as positive and negative theories.

2.1 Negative vs. positive theories

Sceptical theory of democracy argues that the inefficiencies of representative government is main reason for persistent failure of economic growth. By focusing on agency conflict theory between elected politicians and public, Buchanan and Tullock (1962) for instance, conclude that a democratic polity can yield inefficient outcomes by enabling various groups to compete for political influence. Besley and Coate (1998) synthesize a vast literature that models the distortions caused by incumbent politicians running excessive deficits to guarantee re-election. Landau (1986) finds, for instance that: "democracy is an expensive luxury for poor countries". Similarly, Kormendi and Meguire (1985) find "...a negative but only marginally significant, effect of civil liberty on economic growth".

Persson and Tabellini (1994) show that the negative correlation between inequality and growth is only present in democracies. Indeed, some proponents of sceptical theories stress the 'need for a strong state with an iron hand' that neglects populist demands. The economic success of East Asian countries which depicted remarkable growth under non-democratic regimes, offers an illustrative validation for this theoretical conjecture. Recently Tavares and Wacziarg (2001) studied the channels through which democracy influenced growth and showed that democracies are associated with low levels of private investment and high government spending, which in turn hurt economic success.

A more qualitative explanation of the role of democracy on economic growth could result from the explanation of flexible production structure advanced by Fagerberg (2000). Democratic set up can encourage flexible production structures which is beneficial for higher productivity and growth. Advocates often point out that democracy increases productivity and service delivery from a more fully engaged and happier workforce. Other benefits include less industrial dispute resulting from better communication in the workplace, improved and inclusive decision making processes resulting in qualitatively better workplace decisions, decreased stress and increased well-being, an increase in job satisfaction, a reduction in absenteeism, and improved sense of fulfillment.

Probably the most widely known empirical finding in favor of the democratic process is Sen's (1999) observation that a famine has never occurred in a democratic society. Scully (1988) reiterated that "Politically open societies ... grow at three times the rate and are two and one-half as efficient as societies in which these freedoms are abridged". Similarly, Grier and Tullock (1989) find that political repression has a negative impact on growth in Africa and in the non-OECD western hemisphere. Pourgerami (1988) offers a cross-sectional causality test and finds that "a significant positive association between democracy and growth". Azam (1994) in an interesting theoretical work showed that development is a function of democracy where the optimum level of democracy is related to economic growth. He argues, however, that "democratization is not unambiguously an optimal response to exogenous shocks".

Rodrick (1999) shows that democratic economies have better adaptive capabilities against adverse shocks. Positive growth effect of democracy has also been found in the 'channel' analysis of Tavares and Wacziarg (2001) where positive effect of democracy on economic growth can be realized through human capital. The key idea in the positive theories is that democracies may be growth enhancing because they are associated with lower political instability (Alesina and Perotti, 1996; Alesina, et al., 1996) and lower output volatility (Quinn and Woolley, 2001). Isaksson (2007) evince that democracy and economic freedom may promote economic growth via technical change and have a negative effect on capital accumulation but that the net effect on overall growth is positive. And very recently Knutsen (2009) finds robust empirical support that democracies produce higher economic growth through improved technical change than autocracy.

Another related argument often put forward in the literature is the institutional theories. Engerman and Sokoloff (2003, p.14) point out, different institutions may have different implications for economic growth. Depending upon the manner in which institutions evolve, or are designed, in a society, they may develop to favor interests of more powerful groups at the expense of others, or even the population at large.

Indeed, better institutions create more incentives for savings and investment, leading to higher economic growth. The literature highlights three main institutional issues, namely, enforcement of property rights, constraints on the actions of various power groups within the economy, and equal opportunity for broad segments of society (enhanced investment in human capital and participation in productive activities). Institutions are also important for enhancing the process of learning and innovation, and hence total factor productivity growth. Sachs (1999)

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argues that, because this process is so complex, markets alone should not be left to govern it. Although markets provide incentives for innovation, they do not cater for the optimal provision of knowledge (because it is a public good its provision is below the social optimum). This suggests a role for the state. In any case, a mix of market and state appears to be a characteristic of every innovative society, where the state is responsible for patent laws, subsidies, education, and so on.

Acemolglu, Johnson, Robinson, and Yared (2005, 2006) argue that colonial institutions influenced both economic and political development. They advocate that although democracy and income may well be mutually reinforcing, the strong correlation between the two is mainly driven by hard-to-quantify variables related to colonial heritage and early institutions. To summarize, it appears that positive and institutional theories lie at the heart of many theoretical and empirical studies and political commentators seem to have been deeply influenced by the prospective long-run positive effect of democracy on growth.

3 Democratic distribution and analysis of partial effect

From the discussion above, it appears that recent research weighs the positive rather than negative effect of democracy on growth although the timing of democracy (Papaioannou and Siourounis, 2008) and the speed of transition from autocracy to democracy is important. The perceived long-run positive growth effect of democracy along with the inherent structural constraints an economy faces over time lead to the possible existence of low- and high-level of democratic equilibrium. This can be reflected by the presence of 'humps' in the democratic distribution. In effect, countries which are at low-level of democratic equilibrium tend to shift to high-level democratic equilibrium over time. Spatial interdependence in economic growth then occurs at both 'humps' but the larger concentration of economies at high democratic levels indicate that countries tend to depict a 'herd' behavior because they realize that the economic and social benefit of having a neighbor (both in geographic and relational sense) with better institutional quality improves his own future growth trajectory. To investigate further, in this section we study first the changes in the distribution pattern of democracy at cross-country level over four decades (viz., 1970s, 1980s, 1990s, 2000) and explore if a 'democratic convergence club' exists within economies where democracy as cohesive factor creates certain groups or clubs. Distributional dynamics of per capita income growth is also studied over these periods to understand how distribution of economic growth evolves with democracy.

Per capita income is measured by the real GDP per capita (at 2001 purchasing power parity with thousand US dollars). The data has been obtained from the Penn World Table 6.3 (see Heston et al., 2009). The democracy data is taken from the Polity IV Project ($http : //www.systemicpeace.org/inscr/inscr.htm$). The democracy index (DEMOC) is an additive eleven-point scale (0-10) based on four dimension of democracy: (1) Competitiveness of Executive Recruitment (2) Competitiveness of Political Participation (3) Openness of Executive Recruitment (4) Constraint on Chief Executive Democracies score 10 and autocracies score 0 according to this index. Since we are interested in growth of output, this has been calculated by as $\ln(y_t) - \ln(y_{t-1})$ where lag of output at period $t-1$ is denoted by y_{t-1}. The time frame is 1970-2004 with annual frequency for both variables.[5]

3.1 Distribution

To assess changes in distributional pattern in democracy and real GDP per capita, we have estimated the respective Kernel densities for 85 countries[6] performed for each decade beginning 1970 till 2000. The choice of countries is motivated first by the size of population and second by the availability of democracy data. To estimate Kernel density without imposing too many assumptions about its properties, a non-parametric approach is used based on a kernel estimator of $f(X) = \frac{1}{Nh} \sum_{j=1}^{M} K\{\frac{1}{h}(X - x_j)\}$, where $K\{\}$ is the kernel function and h is a 'window width' or smoothing parameter. $h = C\sigma M^P$, where we have used $P = -0.2$ and $C = 1.06$. Gaussian kernel for K has been utilized for estimation.

In Figure 1 we observe a clear bimodal distribution of democracy for each decade which suggests the possibility of a *democratic poverty trap*. This concept points to the existence of 'convergence clubs' in terms of democratic performance: countries are concentrated around two levels of the democratic levels. At theoretical level this would imply the existence of multiple equilibria (i.e., equilibria at low and high democratic levels) which explains the existence of democratic poverty trap. The visible hub-structure has remained unchanged over four decades, with interesting implications that with each passing decade, the concentration of countries has shifted from low level democracy (higher mode in 1970s) to high level of democracy (higher mode in 2000s). The perceived change points at the increasing relevance of democracy over the forty years period. Such bimodal structure is not, however, reflected in the per capita income

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[5]Although historical data for real GDP per capita is available for most of the countries (going as far as 1870 for developed nations), we limit our sample for three decades as democracy data for some developing countries are available since 1970.

[6]There are 62 developing and 23 developed countries.

growth distributions presented Figure 2 where the thick dotted lines are kernel density plotted against the normal densities (thin lines). The distinction in distributional changes in this case is perceived first with respect to the spread of the distribution: year 2000 has higher kurtosis than the year 1970 and second by the visible prolonged tail in 1990 and 2000 reinforcing the fact that some countries still lie at the low level of equilibria, a fact reflected by democratic distribution.

Insert Figure 1 about here

Insert Figure 2 about here

3.2 Partial effect

From the analysis so far, it is now understood that democratic distribution has changed from low-democratic club to high-democratic club over decades. But, has the sign and magnitude of impact of democracy on economic growth changed over time? Estimated correlation coefficient between democracy and per capita income growth for 85 countries show that the correlation coefficient is positive and the magnitude has been increasing in each decade: viz., 0.043 in 1970, 0.131 in 1980, 0.191 in 1990 and 0.252 for the year 2000. The results of the correlation are only indicative of the changes in the distributional pattern between democracy and economic growth over time, which reveals little about the conditions under which such changes have occurred. To understand the net effect of democracy on economic growth over time, it is necessary to estimate an empirical construct which builds on a reasonable theoretical model explaining democracy and economic growth relationship.

We follow the construct of Barro and Sala-i-Martin (1997) that combines the appealing theoretical features of the models of endogenous growth with the interesting empirical features of the neo-classical model. Following this, the economic growth of a country is allowed to vary with the *levels* of economic development. Unconditional convergence occurs when the relationship between per capita income growth, $(Y/Ngr)_{t,t+n}$ and the initial level of per capita income following this model, is negative. Conditional convergence arises when there is a negative relationship between $(Y/Ngr)_{t,t+n}$ and initial per capita income conditional on a set of state variables, such as democracy, capital stock, population density and variables indicating demographic changes.

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The model[7] can be described as:

$$(Y/Ngr)_{t,t+n} = \Gamma[(Y/N)_t, I_t, S_t, \{(X_D)_{t,t+n}, (S_t)_{t,t+n} * (Y/N)_t\}] \qquad (1)$$

$\Gamma(.)$ is assumed to be a linear function of the variables. $(Y/Ngr)_{t,t+n}$, represents per capita output growth, $(Y/N)_t$ is the initial level of per capita income, I variables supplies information on the 'initial' state of the economy, for instance, population density (Density) and educational attainment (Hcap15-64). The demographic variables (X_D) include the contemporaneous birth rate $(CBR_{t,t+n})$, death rates $(CDR_{t,t+n})$ and age-specific educational attainment levels. S_t variables represent factors influencing economic development as well as changes in the stocks, viz., democracy and capital stock (K), etc. The interaction term, $(S_D)_{t,t+n} * (Y/N)_t$ describes the cross effect of S_t variables (in our case, democracy) with the initial per capita income of an economy, (Y/N).

The empirical specification of equation (1) is constructed to thrive on demographic states due to the fact that demographic variables do not display persistent fluctuations and variability. This lends to necessary stability of the system, which is required to evaluate the predictive performance of the growing variables. Apart from 'democracy' - the variable of our interest, other relevant factors which have been included in our empirical model are physical capital stock, population density and human capital. The inclusion of population density reflects the rate of technical change induced by 'demand-push' factors. Human capital is represented by educational attainment of total population between the age 15-64 (Hcap15-64). The empirical specification is as follows:

$$(Y/Ngr)_{i(t,t+n)} = \alpha_i + \eta_t + \beta \ln(Y/N)_{it} + \zeta_1(democracy)_{it} + \zeta_2(democracy * Y/N)_{it} +$$
$$\zeta_3(Density)_{it} + \zeta_4(CBR)_{it} + \zeta_5(CBR * Y/N)_{it} + \zeta_6(CDR)_{it} + \zeta_7(CDR * Y/N)_{it} \quad (2)$$
$$+ \zeta_8(Hcap15 - 64)_{it} + \zeta_9(Hcap15 - 64 * Y/N)_{it} + \zeta_{10}K + \varepsilon_{it}$$

where time specific and cross sectional effects are captured by η_t and α_i respectively and negative value of β would imply convergence. Estimation of this model requires data on CBR, CDR, Hcap15-64, density and physical capital stock (K). As before, real GDP per capita, is obtained from the Penn World Table 6.1 for 85 countries (62: developing and 23: developed countries).

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[7]Note that, while in theory all variables are measured in exact instant t, in implementation, the measurement (of say, $(Y/N)_{t,t+n}$) is over the period $(t, t+n)$. Studies employ five-, ten-, 25-year, or even longer periods (Kelley and Schmidt, 2001).

Data on the crude birth rate (CBR) and the crude death rate (CDR) have been collected from the US Census Bureau, while density, and physical capital stock have been collected from the World Bank Development Indicators. CBR, and CDR are measured per 100 population, and density is measured per 1000 population. Finally, educational attainment data which measures human capital has been obtained from IIASA-VID[8] Data on these variables have been aggregated over decennial periods keeping in mind the possibility of persistence and simultaneity between the dependent and explanatory variables.

By aggregating over longer growth periods (say 10 year aggregation in our case), the differential Y/Ngr growth rates can alter Y/N enough to influence substantially the pace of demographic change and change at democratic level. Like fundamental demographic variables, e.g., birth and death rates, level of democracy also does not experience sudden movement, unless an exogenous shock unsettles the transitional dynamics leaving a long-lasting impact on the economy. By introducing decennial aggregation, we are also conforming to the strategy of recent literature that timing of democratization is an important determinant of growth. Democratization does not occur instantaneously. A nation is not built in a day. The process of democratization indeed has a resemblance with the process of demographic transition. Both are intertwined because a better and quality demographic state (that is a country with higher human capital, for instance) is key to ensure sustainable democracy - a result which is also empirically supported. The per capita output growth (the dependent variable of our model) is not an 'instantaneous' growth rate. In the empirical literature, growth models often use 'growth over periods' and not 'instantaneous growth'. Hence in the present exercise, the per capita output growth rate is: $\sqrt[n]{(Y/Ngr)_{t+n}/(Y/Ngr)_t} - 1$. n, in our case, is 10 years. It is expected that CBR will have growth retarding effect (negative sign), CDR, human capital, population density and physical capital stock have growth-enhancing effect (positive sign).

To assess the impact of democratic distribution on economic growth we performed cross-sectional regression separately for each decade, 1970, 1980, 1990 and 2000. The results are presented in Table 1. Significance of these variables are evaluated based on t-statistics (figures in brackets). Joint significance levels are reported for each component with their interaction terms. From Table 1, no evidence of convergence is observed (the coefficient of initial per

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[8]Lutz et al. (2008) constructed a new dataset of educational attainment by age groups for most countries in the world at five-years intervals for the period 1970-2000. The construction of this database was carried out as a joint exercise between the International Institute for Applied Systems Analysis and the Vienna Institute of Demography. Recent research (viz., Lutz et al., 2008 and Crespo-Cuaresma and Mishra [2011]) points at the critical importance of age-structured human capital in growth and development.

capita income is positive but statistically insignificant). As such the effect of democracy on economic growth is observed to be negative and significant in each decade. At the same time, cross-effects of democracy on economic growth is positive and significant at 5 per cent level. Birth rates (CBR) appears to have growth-enhancing effect however these are not statistically insignificant. Effect of death rate on economic growth is negative and significant indicating the expected result that if crude death rate rises, per capita output growth falls. Significant growth-enhancing effects are also observed for population density, representing technical change and capital stock, representing regenerative capacity of the economy in case of external shocks. The significance of the variables in the regression has been increasing in each decade as can be seen from rising adjusted R^2 values.

Insert Table 1 about here

Based on this table along with the calculated variable medians, one can estimate the partial effect of the variables of interest. Following our objective, the partial effect of democracy is evaluated at the (Y/N) median for all countries and separately for developed and developing countries using the formula:

$$\frac{\partial (Y/Ngr)_{i(t,t+n)}}{\partial (Democracy)_{it}} = \hat{\zeta}_1 + \hat{\zeta}_2 * Median(Y/N)_{it} \tag{3}$$

The results are presented in Table 2. The median income has been rising steadily for both developing and developed countries (column two) and as expected the growth is faster for developed than developing countries. Column three in Table 2 presents estimated partial effects which uses equation 3. A $\pm\sigma$ have been calculated (see appendix for details of the procedure) to lend support of the statistical significance of partial effects. Considering the case of developing countries, beginning with a negative partial effect in 1970, the growth-enhancing effect of democracy has grown steadily over each other decades. Developed countries have evinced significant and larger partial effect of democracy and per capita growth than developing countries. This result also conforms to the observations in the literature that while democracy is fragile in poor countries, it is impregnable in developed ones (Prezworksi, 2005). However, the impact of democracy in developing countries, as such is not negative and significant. Rather, it provides evidence that in a world of interdependent economies, democracy is playing a significant and growth-enhancing role.

4 Dynamic interdependence and complementarity analysis

In this section, we present an empirical growth model with spatial interdependence where 'interdependence' is captured by democratic distance among countries. The evidence of bimodal distribution of democracy and its positive partial effect in economic growth as eked out in the previous section leads one to question if distance among countries' democratic distribution determine the extent of cross-country economic growth interdependence. The latter has been extensively studied in the context of international policy coordination (e.g., Tamura, 1991 and Blackburn and Ravn, 1993) with human capital impersonating as the 'proximity' factor among countries facilitated by knowledge spillovers. In similar line, one may argue that democratic spillover also acts as cohesive factor in cross-country economic growth interdependence, whether considered from purely geographic or relation point of view. A country which enjoys high level of democracy will tend to encourage the level of democracy among neighbors (from geographic point of view with the idea of improving cross-border stability so as to promote stability and growth in the home country) and relationally with both neighbors and others to promote trade and scientific collaborations. State of democracy creates an implicitly feeling of trust among countries wishing to cooperate with others. Countries' economic growth are then dynamically and spatially interdependent driven by the positive externalities of democratic spillovers.

At the core of our proposed spatial empirical growth model lies a simple theory drawn from the literature of international policy coordination, endogenous economic growth and economic geography. Follow Mishra et al. (2011) the simple analytical construct on which our empirical model is based considers two symmetrical economies with stationary population growth, where the welfare of the people in each economy is positively affected at each point in time by the level of consumption c it consumes and by the amount of democracy q it enjoys. Each agent allocates a fixed time endowment between leisure and investment in democratic production (denoted by λ). The social planner in country i then maximizes a welfare function subject to consumption dynamics and a democratic production function.

$$max.W_i = \sum_{t=0}^{\infty} \beta^t [\log(c_{it}) + \nu \log(1 - \lambda_{it})] \tag{4}$$

$$s.t.c_{it} = (1 - \tau_{it})q_{it} \tag{5}$$

$$q_{it+1} = A(q_{it}\lambda_{it}^{\alpha})g_{it}^{\gamma}Q_{it}^{\psi}Q_{jt}^{1-\alpha-\gamma-\psi} \qquad (6)$$

Equation (6) describes democratic production. A: learning parameter, Q_{it}: aggregate level of democracy at home and captures spillover effects within the same country (e.g., across states). H_{jt}: (Average) aggregate democracy level abroad. τ_{it} is flat-rate income tax, g_{it}: public expenditure for provision of social infrastructure and law and order. The inclusion of g_{it}, H_{it}, H_{jt} implies that there are national and international externalities in the production of democracy. Considering this setting and assuming that governments are characterized by cooperative and non-cooperative behavior, then it is possible to show that cooperation among countries with respect to democracy and economic growth leads to higher social welfare than non-cooperative and strategic governments. This is also the fundamental result of Mishra et al. (2011) with respect to democracy and Blackburn and Ravn (1993) with respect to human capital accumulation. The implications of these results are far reaching, especially in the design of a testable empirical spatial growth model where one can test for complementarity/interdependence in growth processes among countries.

4.1 Empirical construct

To build an empirical model, we follow convention and assume that economic growth of a country i where $i = 1, \ldots, n$ is depend on physical capital with an additional variable, democracy, which can be regarded as an input to production. Indeed, democracy can be regarded both as a good in its own right, and as an input in the production of material welfare (Azam, 1994). The idea is to consider that at the optimum point, the marginal cost of democracy in terms of foregone output can be positive or negative. In our case, we allow growth to be an increasing function of the level of democracy. Although one may argue that reducing democracy to a one-dimensional quantity of a good 'for which more is better than less' is a drastic simplification, it nevertheless gives rise to a simple model.

Following Azam (1994), we specify the following country specific production technology[9]:

$$Y = max\{F(K, Q; \zeta), 0\} \qquad (7)$$

where Y is the aggregate production possibility for an economy, K is the aggregate physical capital stock, which is a state variable, and Q is the level of democracy. Function F is assumed

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[9]The fact that the availability of labor is not a constraint on output is now a usual assumption in the growth literature (see for instance, Barro, 1990 and Rebelo, 1991).

to follow standard properties, i.e., $F(.)$ is twice continuously differentiable, strictly increasing in K, and homogeneous of degree one and concave with respect to K and Q. In addition, ζ represents an exogenous shock variable, which impart negative impact on the production possibility. In the above, we rule out negative values of output.

The impact of Q is assumed to be bell-shaped with a positive impact when $Q < \delta K$ and a negative impact when $Q > \delta K$, where δ denotes the constant rate of depreciation of physical capital, K. Output goes to zero when $Q = \delta_0 K$. From the above it can be discerned that the marginal rate of technical substitution between Q and K, $MRTS_{Q,K} = MP_Q/MP_K$ where MP denotes marginal products. The value of democracy in the production process can be gauged from looking at the estimates of $MRTS_{Q,K}$ which reflect the rate at which the amount of Q is substituted for K. Normally, we would expect that the higher is the marginal product of Q in an economy in relation to marginal product of K, the more efficient the economy is, which in the resource optimization and consumption process proves to be more welfare maximizing.

Equation 7 provides a simple mechanism to model the assumption that democracy is an input in the aggregate production process. If one regards freedom of association as being 'more' democratic than individual freedom ('free market'), then the bell-shaped function of Y with respect to K and Q follows which implies that

$$F_k > 0, F_{KK} < 0, F_{QQ} < 0, F_{KK}F_{QQ} - F_{KQ}^2 = 0, F_\zeta < 0 \tag{8}$$

and $F_D \gtreqless 0$ as $Q \lesseqgtr \delta K$, where $F_Q(K, \delta K; \zeta) = 0$. In the above the partial derivatives are denoted by subscripts. This specification of production possibility for an individual country can be generalized for a multi-country setting. Since our idea is to investigate the effect democracy on economic growth at cross country level, the usual assumption of the above described production with respect to democracy and physical capital stock remains constant. However, there is a possibility that ζ for country i and j can be correlated where $i \neq j$ and this is an issue which we will deal with in the estimation strategy and model specification shortly.

To introduce multi-country setting, assume as before that there are N countries indexed by $i = 1, \ldots, N$. Each country's production technology is assumed to follow a constant returns to scale Cobb-Douglas production function with respect to Q and K. Countries are assumed to be distributed over the Euclidean space, such that the distance among them can be described by inter-point locations which may be characterized by either geography or economic-demographic relation. It may be noted that the individual idiosyncrasies of production technology are pre-

served in the Euclidean space. However, while aggregated, the production function may exhibit patterns which are different from individual behavior. The production function is described by:

$$Y_i(t) = A_i(t)Q_i(t)^\alpha K_i(t)^{1-\alpha} \tag{9}$$

where $A_i(t)$ is total factor productivity or the Solow residual, K_i is physical capital, and Q_i the level of democracy as defined before and α delineates the importance of democracy in output.

This production function can be presented using spatial dynamics, which requires us to construct a 'distance' matrix among countries so that per capita output growth of country i will be determined dynamically by its own past growth as well as by growth externalities among countries with whom the country is close either from relational or geographic or from both point of view. Essentially, we represent the connectivity between a country i and all other countries belonging to its neighborhood by the exogenous term, broadly defined as distance, D_{ij}, for $j = 1, \ldots, N$ and $j \neq i$. We assume that these terms are non-negative, non-stochastic and finite; $0 \leq D_{ij} \leq 1$ and $D_{ij} = 0$ if $i = j$. We also assume that $\sum_{i \neq j}^{N} D_{ij} = 1$ for $i = 1, \ldots, N$. The more a given country i is connected to its neighbors, the higher D_{ij} is, and the more country i benefits from spatial externalities. This interdependence structure implies that countries cannot be analyzed in isolation but must be analyzed as an interdependent system whereas in our case interdependence is facilitated by distance among countries with respect to democratic levels.

4.2 Spatial Vector Autoregression model of democracy and economic growth

The spatial dynamics described above can be captured and estimated using a semiparametric spatial vector autoregression framework (spatial VAR as in Chen and Conley, 2001). The purpose of using a semiparametric method is to uncover any hidden non-linear dynamics between cross country economic growth and democracy. As before the underlying assumption is that economic growth among countries will be dynamically dependent on their own as well as cross-country effects with time and locational lags. We then study dependence of 'observations' over spatial lags (similar to dependence in time lags).[10] In our model, the dynamical relationship is upheld by correlation in the democratic level and where the structure of the error term allows for a general type of spatial correlation across countries. This setting allows us to quantify the effect

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[10]The dynamics of dependence of observations across time has been extensively documented in the statistical/econometric literature. Conceptualized in the form of long-memory time series, it says that when observations are correlated over time, the dependence structure displays some memory properties. In spatial context, the strength of dependence is measured between two spatial locations and not by time differences.

of *democratic distance* on economic growth co-movement among countries.

Our spatial VAR specification combines elements of democratic production function (equation 6 and 9). Accordingly, we present a simple model of spatial growth dynamics which is intended to study interdependence and complementarity in cross-country growth processes.

To briefly illustrate the spatial VAR[11] model (see Chen and Conley, 2001 for details) , let $\{Y_{i,t} : i = 1, \cdots, N; t = 1, \cdots, T\}$ denote the sample realizations of economic growth variables for N countries at locations $\{s_{i,t} : i = 1, \cdots, N; t = 1, \cdots, T\}$ where locations are characterized by level of democracy. Now, let $\mathbf{D}_t$ be a stacked vector of distances between the $\{s_{i,t}\}_{i=1}^N$ defined for two points i and j as $\mathbf{D}_t(i,j) = \|s_{i,t}, s_{j,t}\|$ with $\|.\|$ denoting the Euclidean norm. Then,

$$\mathbf{D}_t = [D_t(1,2), \cdots, D_t(1,N), D_t(2,3), \cdots, D_t(2,N), D_t(N-1,N)]' \in \mathbb{R}^{\frac{N(N-1)}{2}}$$

Moreover, the distances are assumed to have a common support $(0, \mathrm{d}_{\max}]$ for all t, $i \neq j$. We assume that the economic growth of a given country denoted at $t+1$ denoted $Y_{i,t+1}$ will depend not only on its own past (home externalities), but also nonparametrically on the performance of its neighbors (spatial spillovers effects). Given the history $\{Y_{t-l}, D_{t-l}, l \geq 0\}$, our specification is given by

$$Y_{i,t+1} = \alpha_i Y_{i,t} + \sum_{j \neq i}^N f_i(\mathbf{D}_t(i,j))Y_{j,t} \tag{10}$$

where the α_i parameters describe the *strength of externalities* generated by home growth, f_i are continuous functions of distances mapping from $(0, \infty)$ to $\mathbb{R}^l$. One interesting feature in this specification is that it does not assume an *a-priori* parametric specification of neighborhood structure as usually done in parametric spatial models.

Let us denote $\mathbf{Z}_t = (Y_{1,t}, Y_{2,t}, \cdots, Y_{N,t})' \in \mathbb{R}^N$ as a vector stacking $\{Y_{i,t}\}_{i=1}^N$. Following Chen and Conley (2001), we model the joint process $\{(\mathbf{Z}_t, \mathbf{D}_t) : t = 1, \cdots, T\}$ as a first order Markov process which designs the evolution of $\mathbf{Z}_t$ according to the following nonlinear Spatial Vector Autoregressive Model (SVAR):

$$\mathbf{Z}_{t+1} = A(\mathbf{D}_t)\mathbf{Z}_t + \varepsilon_{t+1}, \quad \varepsilon_{t+1} = Q(\mathbf{D}_t)\mathbf{u}_{t+1} \tag{11}$$

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[11]A spatial vector autoregressive model (SVAR) is defined as a VAR which includes spatial as well as temporal lags among a vector of stationary state variables. SVARs may contain disturbances that are spatially as well as temporally correlated. Although the structural parameters are not fully identified in SVAR, contemporaneous spatial lag coefficients may be identified by weakly exogenous state variables.

where $A(\mathbf{D}_t)$ is a $N \times N$ matrix whose elements are functions of democratic distances between countries. We assume that $\mathbf{u}_{t+1}$ is an i.i.d. sequence with $\mathbb{E}(\mathbf{u}_{t+1}) = 0$ and $\mathbb{V}(\mathbf{u}_{t+1}) = I_N$. It follows that the conditional covariance matrix of $\boldsymbol{\varepsilon}_{t+1}$ is $\mathbb{E}(\boldsymbol{\varepsilon}_{t+1}\boldsymbol{\varepsilon}'_{t+1}) = Q(\mathbf{D}_t)Q(\mathbf{D}_t)' := \Omega(\mathbf{D}_t)$ which is also a function of distances. In the specification (11), the conditional mean $A(\mathbf{D}_t)$ and the conditional covariance $\Omega(\mathbf{D}_t)$ are of importance and have to be estimated. They provide explicit characterization of the slopes of functions corresponding to dynamic interdependence in economic growth (i.e., the conditional mean specification) and cross country correlation of errors (or conditional covariance specification) as functions of democratic distances among them.

1. *Structure on conditional means: dynamic interdependence in growth.*

   From (11), the conditional mean of $Y_{i,t+1}$ given $\{\mathbf{Z}_{t-l}, \mathbf{D}_{t-l}, l \geq 0\}$ is modelled as

$$\mathbb{E}\left[Y_{i,t+1}|\{\mathbf{Z}_{t-l}, \mathbf{D}_{t-l}, l \geq 0\}\right] = \alpha_i Y_{i,t} + \sum_{j \neq i}^{N} f_i(\mathbf{D}_t(i,j))Y_{j,t} \tag{12}$$

   where the f_i are continuous functions mapping from $(0, \infty)$ to $\mathbb{R}^l$. The dynamic spatial output correlations are represented by f functions which are time-invariant functions of the distance between two countries. It follows that the conditional mean of $\mathbf{Z}_{t+1}$ given $\{\mathbf{Z}_{t-l}, \mathbf{D}_{t-l}, l \geq 0\}$ is $A(\mathbf{D}_t)\mathbf{Z}_t$, where

$$A(\mathbf{D}_t) = \begin{pmatrix} \alpha_1 & f_1(\mathbf{D}_t(1,2)) & \cdots & f_1(\mathbf{D}_t(1,N)) \\ f_2(\mathbf{D}_t(2,1)) & \alpha_2 & \cdots & f_2(\mathbf{D}_t(2,N)) \\ \vdots & \vdots & \vdots & \vdots \\ f_N(\mathbf{D}_t(N,1)) & f_N(\mathbf{D}_t(N,2)) & \cdots & \alpha_N \end{pmatrix} \tag{13}$$

   and that the spectral radius of $A(D_t)$ is strictly smaller than one. It reflects estimation in a stationary environment.

2. *Structure on conditional covariances: Covariance of spatial errors.*

   Assuming that the Euclidean distance between two spatial locations is defined by $\tau = \|s_1 - s_2\|$ and setting $k = 3$ in $s \in \mathbb{R}^k$ the covariance function can be written following Yaglom (1987):

$$\gamma(\tau) = 2^{(k-2)/2}\Gamma(\frac{k}{2}) \int_0^\infty \frac{J_{(k-2)/2}(x\tau)}{(x\tau)^{(k-2)/2}} d\Psi(x) \tag{14}$$

   where $\Psi(x)$ is a bounded nondecreasing function and where $J_{(k-2)/2}(x\tau)$ is a Bessel func-

tion of the first kind (see Yaglom, 1987 for details). After some algebra and by explicitly introducing the Bessel function, the covariance function becomes,

$$\gamma(\tau) = \int_0^\infty \frac{\sin(x\tau)}{x\tau} d\Psi(x) \tag{15}$$

In the degenerate case $\Psi(x) = x$ so that the covariance function reduces to single hyperbola. Then for every bounded nondecreasing function Ψ, this implies that the conditional covariance is represented by

$$\Omega(\mathbf{D}_t) = \begin{pmatrix} \sigma_1^2 + \gamma(0) & \gamma(\mathbf{D}_t(1,2)) & \cdots & \gamma(\mathbf{D}_t(1,N)) \\ \gamma(\mathbf{D}_t(2,1)) & \sigma_2^2 + \gamma(0) & \cdots & \gamma(\mathbf{D}_t(2,N)) \\ \vdots & \vdots & \vdots & \vdots \\ \gamma(\mathbf{D}_t(N,1)) & \gamma(\mathbf{D}_t(N,2)) & \cdots & \sigma_N^2 + \gamma(0) \end{pmatrix} \tag{16}$$

where $\gamma(.)$ is assumed to be continuous at zero and is k-dimensional isotropic covariance function. The choice of γ ensures that $\Omega(\mathbf{D}_t)$ is positive definite for any set of interpoint distance $\mathbf{D}_t$ and any values of the $\sigma_i^2 \geq 0$. Yaglom (1987: 353–354) showed that an isotropic covariance function has a representation as an integral of a generalized Bessel function. The representation of γ is analogous to the spectral representation of time-series covariance functions.

4.3   Estimation

For simplicity, we assume that the distance function $\mathbf{D}_t$ is exogenous, i.e. determined outside the relation (11). We are interested in the shape of functions f_i and γ specified above. Chen and Conley (2001) propose a semiparametric approach based on the cardinal B-spline sieve method. This approach uses a flexible sequence of parametric families to approximate the true unknown functions. The cardinal B-spline of order m, B_m, on compact support $[0, m]$ is defined as

$$B_m = \frac{1}{(m-1)!} \sum_{k=0}^m (-1)^k \binom{m}{k} [\max(0, x-k)]^{m-1} \tag{17}$$

Hence, $B_m(x)$ is a piecewise polynomial of highest degree $m-1$. Then, the functions of interest f_i and Φ can be approximated by

$$f_i(y) \approx \sum_{j=-\infty}^{\infty} a_j B_m(2^n y - j) \tag{18}$$

and

$$\Phi(y) \approx \sum_{j=-\infty}^{\infty} b_j B_m(2^n y - j) \tag{19}$$

where the index j is a translation and the index n provides a scale refinement. The coefficients a_j and b_j are allowed to differ across these approximations. As n gets larger more $B_m(2^n y - j)$ are allowed and this in turn improved the approximation. Moreover, since B_m is nonnegative, a nondecreasing and nonnegative approximation of Φ can be obtained by restricting the coefficients b_j to be nondecreasing and nonnegative.

The estimation is performed in two-steps sieve least squares (LS). In the first step, LS estimation of α_i and f_i, $i = 1, \cdots, N$ is based on conditional mean in (13) and sieve for f_i using the minimizations problem

$$\left(\hat{\alpha}_{i,T}, \hat{f}_{i,T}\right) = \underset{(\alpha_i, f_i) \in \mathbb{R} \times \mathcal{F}_{i,T}}{\arg\min} \frac{1}{T} \sum_{t=1}^{T} \left\{ Y_{i,t+1} - \left(\alpha_i Y_{i,t} + \sum_{j \neq i} f_i(\mathbf{D}_t(i,j)) Y_{j,t} \right) \right\}^2 \tag{20}$$

where $\mathcal{F}_{i,T}$ denotes the sieve for f_i (see Chen and Conley, 2001). Let us denote $\hat{\varepsilon}_{i,t+1} = (\hat{\varepsilon}_{1,t-1}, \cdots, \hat{\varepsilon}_{N,t+1})$ the LS residuals following from the first stage:

$$\hat{\varepsilon}_{i,t+1} = Y_{i,t+1} - \left(\hat{\alpha}_{i,T} Y_{i,t} + \sum_{j \neq i} \hat{f}_{i,T}(\mathbf{D}_t(i,j)) Y_{j,t} \right) \tag{21}$$

Then, in the second step, sieve estimation for σ^2 and $\gamma(.)$ based on the conditional variance (16), sieve for γ and fitted residuals $\hat{\varepsilon}_{i,t+1}$ is obtained as

$$\left(\hat{\sigma}_T^2, \hat{\gamma}_T\right) = \underset{(\sigma^2, \gamma) \in (0,\infty)^N \times \mathcal{G}_T}{\arg\min} \sum_{t=1}^{T-1} \left\{ \sum_i \left[\hat{\varepsilon}_{i,t+1}^2 - (\sigma_i^2 + \gamma(0)) \right]^2 + \sum_i \sum_{i \neq j} \left[\hat{\varepsilon}_{i,t+1} \hat{\varepsilon}_{j,t+1} - \gamma(\mathbf{D}_t(i,j)) \right]^2 \right\} \tag{22}$$

where $\mathcal{G}_T$ denotes the sieve for γ. Chen and Conley (2001) derived the $\sqrt{T}$ limiting normal distributions for the parametric components of the model. The authors also suggested a bootstrap method for inference as the pointwise distribution result for the nonparametric estimators $\hat{f}$ and $\hat{\gamma}$ is not provided. Moreover, the asymptotic covariances are computationally demanding. Notice that the nonparametric approach is a departure from typical spatial econometric models in which a parametric form of dependence is assumed (see, e.g., Anselin and Griffith, 1988). The spatial model as described above puts restrictions on co-movement across countries that are different from those of typical factor models. In this case, the covariance across variables is mediated by a relatively low dimensional set of factors as in, for example, Quah and Sargent (1993) and Forni and Reichlin (1998).

5 Spatial VAR results

5.1 Distance construction and illustration

An important aspect of our empirical investigation is the use of distance metric which defines economic growth interdependence across countries. The proposed distance metric in our case is based on the level of democracy which spans between 0 to 10. A cut-off point can be used such that countries having values of 5 or more are more democratic and less than 5 are less democratic. However, our intention is not compare between 'more or less democratic', instead our idea is to investigate how, as the democratic measure moves on the scale from 0 (i.e., autocratic) to 10 (i.e., full democracy), interdependence among countries' growth processes will accelerate, mainly due to the building-up of trust, increased volume of trade and policy cooperation, etc. To elucidate, assume that we have three countries $i = 1, 2, 3$. The $D_t(i, j)$ for these countries are $D_t(1, 2)$, $D_t(2, 3)$ and $D_t(1, 3)$ which should be positive and non-zero and where the distance between own countries are zeros, i.e., $D_t(1, 1) = 0$, $D_t(2, 2) = 0$ and $D_t(3, 3) = 0$. If country 1, 2 and 3 have values 8, 1 and 6 on the 0-10 democratic scale, we expect that country 1 will interact more with country 3 rather than country 2, because $D_t(1, 2) > D_t(1, 3)$ on the relational space of Euclidean distance. Economic interaction, in terms of trade and policy cooperations depend on how distant a country is from others.

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5.2 Role of geography and distribution of countries

The estimation of spatial VAR (in short, SVAR) has been carried out for 85 countries (62 developing and 23 developed) with and without the effect of geography. To assess the role of geography we have clustered countries with respect to their regional conglomeration attributes, so that countries clustered within each regional group reflect on geographic proximity among them. Relational proximity with respect to democratic distance is studied with and without the assumption of geographic clustering of countries. The identified regional groups are Asia, Africa, Latin-America and Offshore and Europe. It may be stressed that one may use other types of distance measures, such as human capital, language and trade to gauge the relative importance of geographical and relational (here democratic) proximity in spatial growth dynamics. However, some of the issues have already been investigated in the literature. Azomahou et al. (2009) study interdependence in terms of demographic distance represented by similarity in the convergence of population shocks across countries and Parhi and Mishra (2009) studied growth interdependence in Europe by considering similarity in the appropriation tendency of human capital in the countries' production processes. In the present exercise, language is not a prominent cohesive factor as most countries in recent times engage in common language like English and the distance between countries with respect to language may not have a statistically larger impact on growth interdependence. Trade is another possibility, however, the consideration of democratic distance indirectly accounts for high trade engagement on the presumption that similar stable economies engage intensely in international trade than others.

5.3 Results: SVAR

In this section, we present results from spatial VAR regression. In general, evidence of interdependence would indicate that the countries under experiment have developed an intense trust factor which has enhanced interactive economic activities among them. Accordingly, we estimate and present the distribution of distances (plotted as histogram of distances), α (growth interdependence) and σ^2 (error covariance) of the spatial VAR model outlined in the methodology section first for a mix of 43 countries among four country groups, viz., Asia, Africa and Europe. The selection is guided by the estimation results using Cluster algorithm as in Hobijn and Franases (2000) where countries are clubbed according to their common stochastic components. We have used democracy and economic growth variables to run cluster algorithm over three decades period (1970-2000) and have clubbed countries with four or more in different

convergence clubs.[12]

This approach requires us to define, for instance, 'democratic gap' between country i and j which is used in cluster analysis if this gap is converging over time. Second, to investigate if geography play any role in enforcing interdependence in growth, we have divided the countries into four groups as mentioned above. Third, to assess the importance of inter-regional interdependence, we have also estimated spatial VAR for regional groups such as Europe-Asia, Europe-Africa, and Europe-Latin America and Offshore countries. The evidence of positive and significant α in these estimations would indicate growth-enhancing effect of democracy among countries. To save space, graphs of regional groups and the mixed countries will be presented. For inter-regional distributions, we only report estimates of α and σ^2. A note on the use of democracy data is in order. For both mix and regional and inter-regional analysis, the results presented used democratic index. For robustness analysis we have used Polity index only for the mixed country estimation.

5.3.1 Distance distribution

Figures 3-5 present distribution of distances (Figure 3 for mixed countries and Figures 4-5 for regional groups). The histograms presented in these figures reflect that about 85% of the distance of democratic distribution covers about 6.5 on the democratic distance scale. Assuming a cut-off point of median value of 5 on the democratic scale (0-10), the distributions in figure 3 imply that 85% of the democratic distance distribution can explain spatial interdependence in democracy and economic growth - which is what is expected. Because the higher the percentile the distance is covered, the greater will be the interaction among countries growth and cross-country economic growth processes as function of the distance.

Insert Figures 3-5 about here

Among geographically clustered groups, evidence of bimodality is observed for Africa and Latin America and Offshore and bias in the distribution is observed among all groups, Europe depicting comparatively normal distribution structure than others. In all cases, about 85 percent of distribution is covered by democracy level between 6-7, which is over the median of democratic distribution in the scale of 1-10.

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[12]To save space, we have not presented the detailed results here. The results are available with the authors upon request.

5.3.2 Conditional mean (α) and covariance distribution (σ^2)

The coefficient matrix $A(D_t)$ is summarized by the α coefficients on each country's own lagged output growth and the function f that governs the impact of other countries' output growth rates. The conditional variances are described by idiosyncratic components σ_i^2 and the function γ that governs covariances. Interpreted otherwise, the coefficient estimates for α (reflecting dynamic interdependence in economic growth among countries as a function of democracy) and σ^2 (reflecting covariance of residuals among countries as function of democracy). Table 3 describes results from spatial VAR estimation for the analysis of growth and democracy. Note that $\hat{\alpha}$ values are the average estimates over countries. The significance of the coefficients can be gauged by calculating the corresponding pooled t-ratio. A statistically significant averaged α indicates the presence of spatial autocorrelation or dynamic output correlations across countries.

We first investigate the results from the mixed countries. Although $\hat{\alpha}$ is not particularly large (0.154 and 0.167 for the two distance measures) in Table 3, they are positive and are statistically significant. However, as countries are disaggregated into regional groups, sizable and significant spatial effect is observed for some regions and among selected inter-regional groups.[13] In Table 4, we present results of the geographically clustered groups and inter-group estimates of α and σ. Significant spatial interdependence is observed for countries in Europe (with $\hat{\alpha} = 0.244$) and for countries within Europe-Asia cluster (with $\hat{\alpha} = 0.290$). In each case, the $\hat{\alpha}$ values are statistically significant at 5 percent level. Among the country groups, Africa appears to be performing in terms of interdependence followed by Africa-Europe cluster. This is duly presented by the left panel of figures 8-11 for regional groups and figures 6-7 for mixed countries. The figures represent dynamic interdependence where the solid lines are our point estimates of f, plotted against the distances (in the X-axis).

Insert Tables 3-4 about here

In Tables 3 and 4 the averaged conditional variances ($\hat{\sigma^2}$) describe idiosyncratic components (σ_i^2) and indicates that the covariance structure of the residuals also significantly depend on the distances. As expected we find significant error covariance for most of the country groups, Asia, Africa, Asia-Europe and Africa-Latin America where error covariances are not statistically significant. An alternate way to present spatial VAR results would be to discuss about the slope

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[13]The number of countries among the regional groups are a as follows: Europe (21), Asia (18), Africa (23) and Latin-America and Offshore (21). For inter-regional groups, the numbers are addition of the concerned groups.

of f and γ functions (representing dynamic spatial autocorrelation and error covariance functions respectively). The results conform the conclusions from preceding discussions.[14]

As robustness check of our results, we use an alternative democracy index. The index is the Polity index of the Freedom House which ranges from 0 to 10 (where 0 is least democratic and 10 most democratic)[15]. As done above, we have used a cut-off point such that countries having values of 5 or more are more democratic and less than 5 less democratic. Accordingly, we construct democratic distance based on the polity index and this is embedded in spatial VAR estimation. Our results (see bottom part of Table 1) supports our earlier findings: i.e., both γ and f functions display theoretically expected patterns. The magnitude of spatial growth interdependence is 0.167 which is positive and statistically significant at 10% level.

6 Conclusion

The central research idea of the paper was to study the role of democratic distance among countries in understanding spatial growth interdependence. As a first step, we studied the distributional changes in democracy for a sample of 85 countries and showed how democratic cluster is changing shape over decades. Higher number of countries in the higher democratic cluster meant that countries emphasized on the economic value of democracy for their own growth and assuming benevolence, in the growth of neighbors. To assess, if democracy has actually exerted positive effect on growth over decades, we performed a cross-sectional regression for four decades since 1970 and found, contrary to the evidence in a number of studies, the growing and positive partial effect of democracy in economic growth. It was evident that the magnitude of positive effect of democracy was larger for developed nations and smaller for developing nations.

The economic-divide captured by developed and developing country distribution reflects that high-growth countries tend to enjoy higher spillovers from democratic interdependence. Low-income countries enjoy small incentives to cooperate among themselves in terms of growth although their democratic levels may be close to each other. This leaves us with the possibility that low-income democratic countries would benefit more from association with high-income democratic countries. This is reflected from our spatial VAR estimation where countries across regional sub-groups, in our case Europe-Asia - for instance, exhibited significant dynamic spa-

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[14]To save space we have not presented the graphs here, however these can be obtained from the authors.

[15]The Freedom House Polity index is constructed by taking the average of the average of the standard Freedom House Civil Liberties index and its Political Right index. This average is then transformed to a scale 0-10.

tial autocorrelation. To capture the role of absolute geography, we clustered countries within regions having minimum physical distance. It was evident that Europe and Europe-Asia cluster evinced significant spatial autocorrelation. For other regional sub-groups, although the spatial dependence are positive, they are insignificant. Geographical proximity was found to have a significant role in ensuring growth interdependence but that is not consistent across other regional groups. It appears thus that countries value 'relational' proximity with respect to democratic distance while deciding on economic growth interdependence. The role of geography as 'deep determinant' may be overshadowed by relational proximity among countries.

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Table 1: Cross-Section Estimation (Model 3)(N = 85 countries; sample: 1960-2000): Dependent Variable, (Y/Ngr)

	1970	1980	1990	2000
Ln(Y/N)	1.068(1.117)	1.104(1.00)	1.174(1.080)	1.238(1.140)
Democracy	⌈−0.395(−3.00)⌉	⌈−0.414(−3.180)⌉	⌈−0.420(−3.300)⌉	⌈−0.418(−3.310)⌉
Democracy*(Y/N)	⌊0.229(2.36)⌋	⌊0.242(2.530)⌋	⌊0.248(2.650)⌋	⌊0.247(2.660)⌋
CBR	0.946(1.28)	0.969(1.33)	1.069(1.490)	1.126(1.570)
CBR*(Y/N)	-0.205(-1.230)	-0.199(-1.21)	-0.200(-1.24)	-0.204(-1.270)
CDR	⌈−2.858(−3.200)⌉	⌈−2.819(−3.20)⌉	⌈−2.842(−3.280)⌉	⌈−2.841(−3.290)⌉
CDR*(Y/N)	⌊−0.120(−0.670)⌋	⌊−0.133(−0.760)⌋	⌊−0.139(−0.800)⌋	⌊−0.127(−0.740)⌋
Hcap15-64	-0.148(-0.220)	-0.116(-0.180)	-0.142(-0.220)	-0.144(-0.230)
Hcap15-64*(Y/N)	-0.062(-0.500)	-0.067(-0.550)	-0.070(-0.580)	-0.070(-0.590)
K	0.290(2.170)	0.337(2.620)	0.373(3.030)	0.368(3.120)
Density	1.052(1.930)	1.077(2.010)	1.123(2.210)	1.134(2.15)
Constant	0.426(0.120)	-0.810(-0.22)	-1.878(-0.520)	-2.18(-0.61)
R^2	0.439	0.455	0.470	0.479
Adj.R^2	0.355	0.373	0.390	0.394
No. of Observations	85	85	85	85

Note: (i) Bracketed values are t-statistics at 5% level of significance.

(ii) Square brackets over two variables indicate joint significance at 5% level of significance.

Table 2: Partial effects of democracy evaluated at (Y/N) Medians (N = 85 countries; sample: 1970-2000)

Years	ln(Y/N) median	Democracy (partial)	Partial-1.96*σ	Partial+1.96*σ
Developing Countries				
1970	1.626	-0.023	-2.870	2.825
1980	1.993	0.066	-3.747	3.880
1990	2.580	0.220	-4.494	4.934
2000	2.682	0.245	-5.480	5.969
Developed Countries				
1970	7.801	1.391	-4.575	7.358
1980	12.085	2.498	-4.102	9.099
1990	15.782	3.494	-3.568	10.556
2000	19.813	4.476	-4.332	13.283

Table 3: Parameter estimates $\hat{\alpha}$ and $\hat{\sigma}^2$
for democracy and economic growth interdependence

	$\hat{\alpha}$		$\hat{\sigma}^2$		
Distance measure	Coef.	Std-Dev.	Coef.	Std-Dev.	Obs.
Democratic index	0.154	0.0128	0.0029	0.0010	1462
Polity index	0.167	0.098	0.0031	0.0011	1462

Note that the values of $\hat{\alpha}$ and $\hat{\sigma}^2$ reported here are averages across all countries. Obs=NT.

Table 4: Parameter estimates $\hat{\alpha}$ and $\hat{\sigma}^2$
for democracy and economic growth interdependence: Geographic distribution

Country groups	$\hat{\alpha}$		$\hat{\sigma}^2$		
	Coef.	Std-Dev.	Coef.	Std-Dev.	Obs.
Europe	0.244	0.141	0.0005	0.0002	646
Asia	0.176	0.149	0.0005	0.0005	595
Africa	0.004	0.159	0.0009	0.0008	748
Latin America Offshore	0.169	0.128	0.0014	0.0004	748
Africa-Europe	0.094	0.127	0.0023	0.0007	1394
Asia-Europe	0.290	0.147	0.001	0.0003	1190
Europe-Latin America	0.186	0.125	0.0011	0.0003	1496

Note that the values of $\hat{\alpha}$ and $\hat{\sigma}^2$ reported here are averages across all countries. Obs=NT.

Figure 1: Bimodality of democratic distribution: Kernel density plots
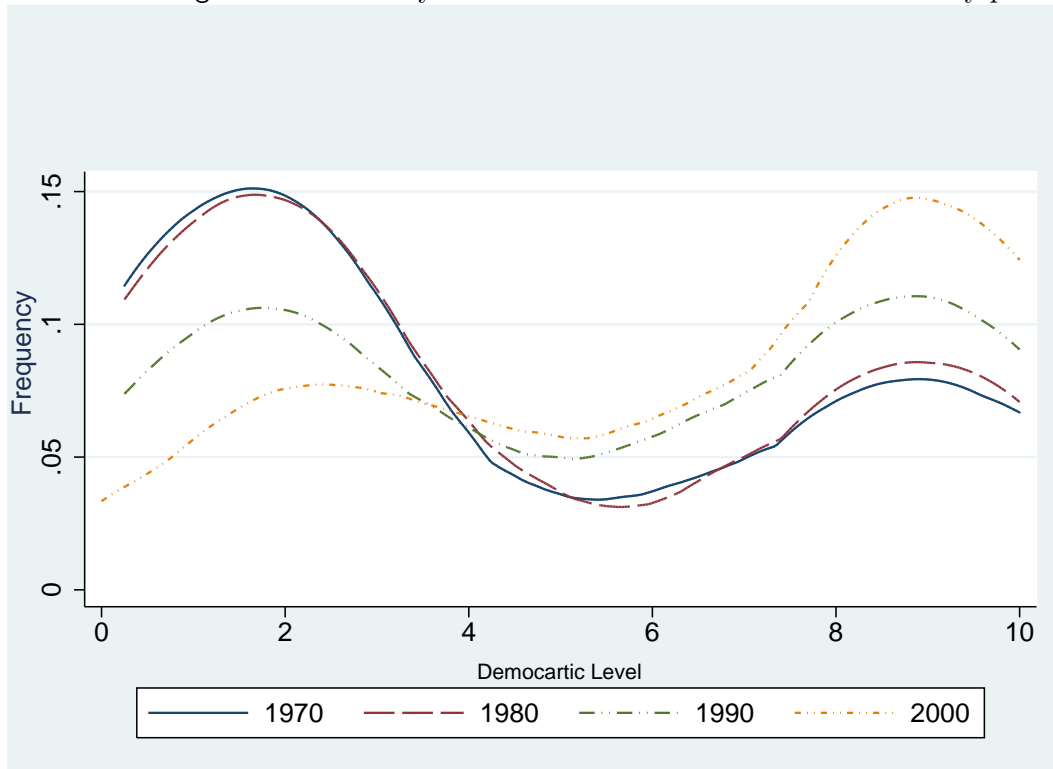
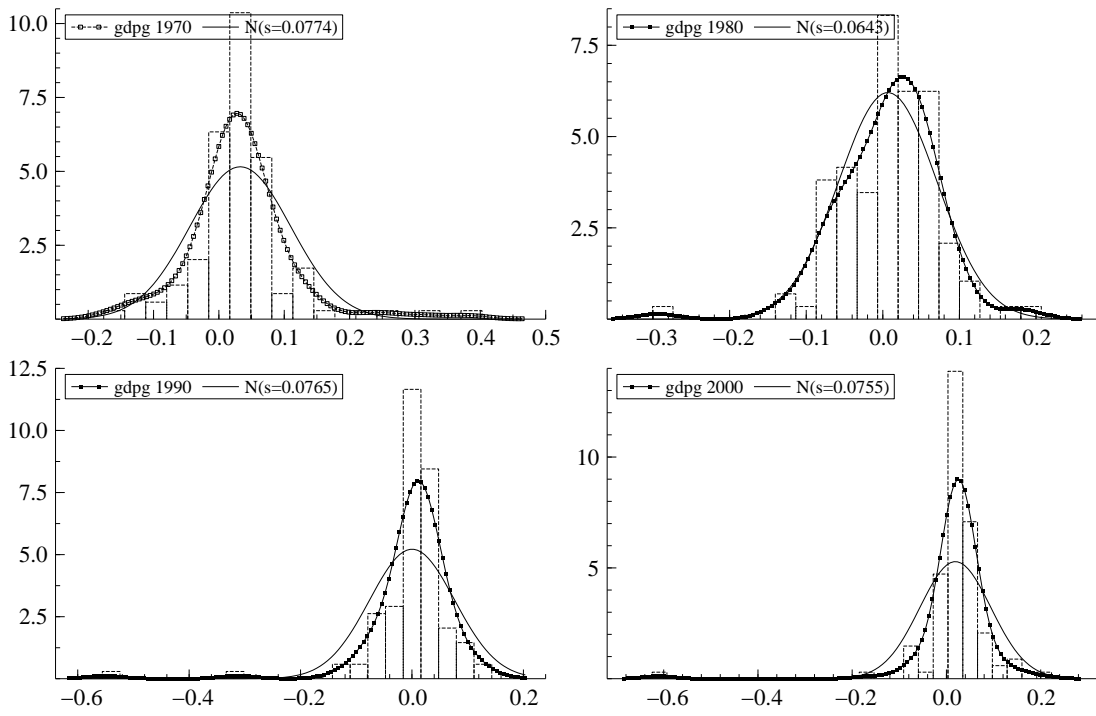Figure 2: Distribution of per capita real GDP
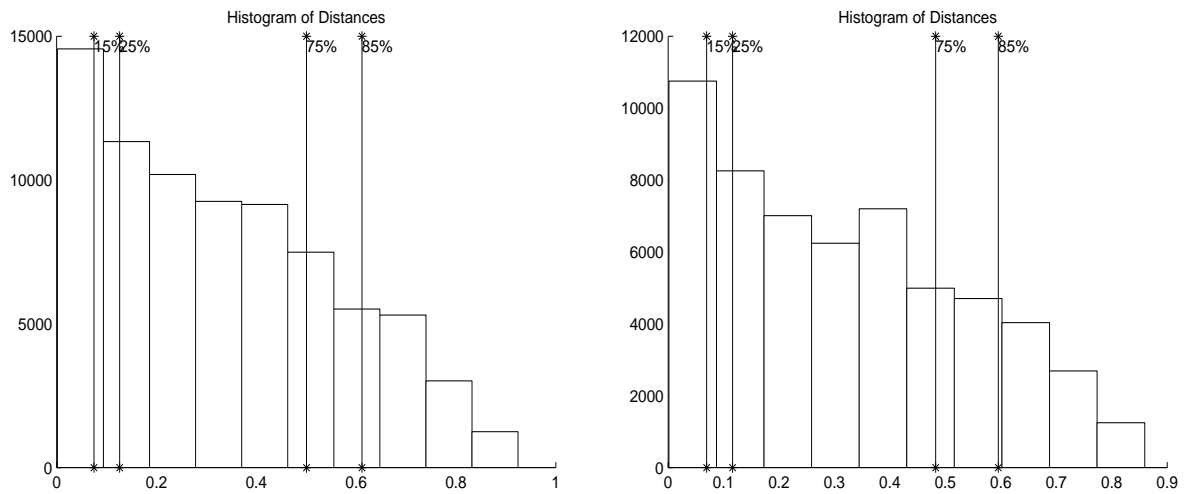
Figure 3: Histogram of distances for mixed countries: Polity Index [left] and Freedom House [right]
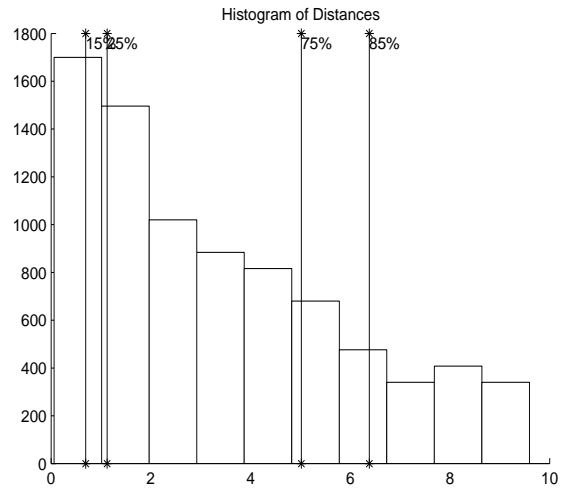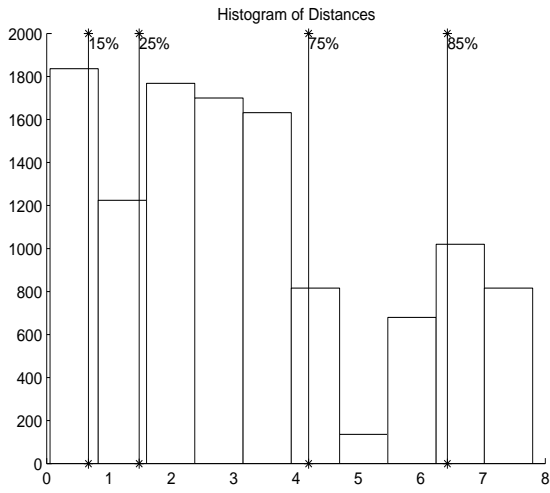
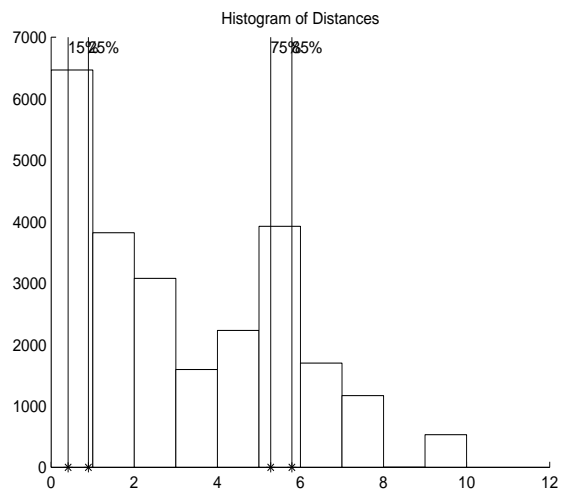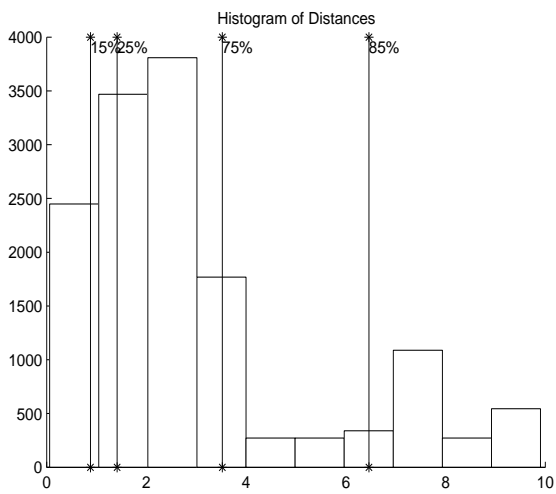Figure 4: Histogram of distances: Europe [left] and Asia [right]

Figure 5: Histogram of distances: Africa [left] and Latin-America and Offshore [right]

Appendix

A. Confidence band for estimates of partial derivatives

Denote the estimate of the partial derivative of democracy(at period t and for the set of countries belonging to developing nations) as P_{st}, where $s = (1, 2)$ and $t = $ (1960-70, 1970-80, 1980-90, 1990-2000). Confidence band of P_{st} at 95 percent significance level (given its mean, $\bar{P}_{st}$, and standard deviation, σ_P) is

$$CI = \bar{P}_{st} \pm 1.96 * \frac{\sigma_P}{\sqrt{N}} \tag{23}$$

$N = 23$ for developed and 63 for developing countries. $\bar{P}_{st}$ is assumed to be the same as the estimated $\hat{P}_{st}$ as

$$\bar{P}_{st} \equiv E[\hat{\delta}_1 + \hat{\delta}_2 * Median(Y/N)] = \hat{P}_{st} \tag{24}$$

Similarly,

$$\sqrt{Var(P_{st})} =$$
$$\sqrt{Var(\hat{\delta}_1) + Var(\hat{\delta}_2) * (Median(Y/N))^2 + 2Median(Y/N)Cov(\hat{\delta}_1, \hat{\delta}_2)}$$