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Yung-hsiang Ying
Undergraduate Program of Business Administration, National Taiwan Normal University

Koyin Chang
Department of Healthcare Information and Management, Ming Chuan University

Ginny ju-ann Yang
Department of Money and Banking, National Kaohsiung First University of Science and Technology

Chen-hsun Lee
Department of Money and Banking, National Kaohsiung First University of Science and Technology

Abstract

In the fields of political science and economics there has been a recent surge of interest in the co-movement of globalization and democratization. Wavelet coherency analysis was first used to measure the co-movement of globalization and democratization in time and frequency domains. We collected our data from the period 1948-2010. The results were as follows: (1) Co-movement is weaker for fluctuations with a duration of less than 3 years during the period from 1950-1990, with the exception of significantly positive co-movement with a duration of greater than 4 years during 1965-1975; and (2) positive long-term, mid-term, and short-term co-movement was indicated after 1990, among which positive short-term to short mid-term co-movement was the most significant. These results suggest that the Cold War influenced the interaction between democratization and globalization.

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Contact: Yung-hsiang Ying - yying@ntnu.edu.tw, Koyin Chang - kychang@mail.mcu.edu.tw, Ginny ju-ann Yang - ginny@nkfust.edu.tw, Chen-hsun Lee - leeblade@nkfust.edu.tw.
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Yung-hsiang Ying
Undergraduate Program of Business Administration, National Taiwan Normal University

Koyin Chang
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In the fields of political science and economics there has been a recent surge of interest in the co-movement of globalization and democratization. Wavelet coherency analysis was first used to measure the co-movement of globalization and democratization in time and frequency domains. We collected our data from the period 1948-2010. The results were as follows: (1) Co-movement is weaker for fluctuations with a duration of less than 3 years during the period from 1950-1990, with the exception of significantly positive co-movement with a duration of greater than 4 years during 1965-1975; and (2) positive long-term, mid-term, and short-term co-movement was indicated after 1990, among which positive short-term to short mid-term co-movement was the most significant. These results suggest that the Cold War influenced the interaction between democratization and globalization.

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1. Introduction

After World War II, economic globalization spread more rapidly with the increase in trade interaction between countries. The inevitable exchanges of international economics promoted growing openness and economic integration across the world. After the Cold War, more and more countries attached great importance to developing their individual political regimes through the founding of constitutional government alongside national economic development. These issues of globalization and democratization have recently become the focus of many researchers of contemporary political economics. For example, Quinn (2001), Dreher (2006), Patti and Navarra (2009) and Yu (2010) claimed to have found various linkages between democratization and trade over different kinds of overlapping or non-overlapping time periods. Among the vast previous literature, economists and political scientists remain strongly divided over the nature and causality of the relationship between global trade and democracy. The relationships remain inconclusive. Each of these seemingly contradictory viewpoints, indeed, has a sound basis of discourse, varying only in relation to points of occurrence and the different states in which positive/negative influences are generated. We were therefore motivated to investigate the relationship between democracy and trade liberalization after World War II and how the Cold War influenced this relationship. This study outlines the co-movement of democratization and globalization at different times and frequencies.

The remainder of this study is organized as follows. Section 2 presents the literatures. Section 3 presents the data that used in this study. Section 4 describes the methodology. Section 5 presents our empirical findings. Finally, Section 6 presents some concluding remarks.

2. Background of the relationships between democratization and globalization

A number of studies have indicated that globalization can indeed facilitate economic growth (Dreher, 2006). However, theories on the relationship between democratization and globalization are still inconclusive. Below is a brief description of this relationship:

2.1 Democratization on globalization

There have been conceptually positive and negative effects of democratization on globalization. The positive effects can be summarized by the theory that governments in labor-rich countries can increase the liberalization of trade policy through the promotion of democracy (Milner and Kubota, 2005). Barro (1996; 1999), Rodrik (2000), Quinn (2001) and Milner and Kubota (2005) discovered evidence that

democratization positively affects globalization. On the other hand, in developed countries, democracy leads to labor-friendly trade policies serving as instruments for protectionism. Therefore, O'Rourke and Taylor (2006) claim that democracy has a negative effect on trade in developed countries. Therefore, O'Rourke and Taylor (2006) find evidence of a negative effect of democracy on trade in developed countries.

2.2 Globalization on Democratization

On the positive side, according to Lipset (1981), an increase in international exchange driven by globalization has raised the awareness of lifestyles in other countries. Through globalized exchange, the democratic systems of industrialized nations can be transmitted to other developing nations, encouraging the growth of democratization. In addition, using a powerful series of instrumental variables proposed by Frankel and Romer (1999) and Rose (2004), López-Córdova and Meissner (2005) found that international trade has a positive influence on democratization.

On the other hand, globalization causes domestic products to lose the advantages of exclusiveness and protection in the domestic market, leading to the increase of unemployment rates and thus social problems, reduction in government efficiency, and damage to democracy. Rigobon and Rodrik (2004) argued the fundamental harm to democracy caused by globalization is that market demands heavily restrict the range of democratic choice (Garrett, 1998). de Vries (2001) indicated that globalization reduces the function of the nation-state and negatively influences national democratic systems. Capital account liberalization allows one country to promote the free flow of all kinds of assets within a capital account. This increased capital flow of international private assets places banks of developing countries at high market risk. Dailami (2000) indicated that the possibility of capital account liberalization limits the collection and allocation of tax revenue, and restricts regulatory and risk diversification policy. This weakens support for democratic forms of government. Recently, numerous empirical findings to support this view can be found in Bussmann (2002), Li and Reuveny (2003), Boix (2003), Rigobon and Rodrik (2004), Decker and Lim (2007), Eichengreen and Leblang (2007) and Tavares (2007).

The above theoretical and empirical results of these studies on globalization and democratization appear to lack commonality and consistency, and can even appear to be contradictory. The reason for these contradictions or inconsistencies may be that the relationship between globalization and democratization is dynamic and changes with time. Previous studies have researched this relationship in the context of a time domain, which produced a mean outcome representative of the sampling period only.

These findings did not accurately depict the dynamic and constantly changing relationship between these two forces, leading to inconsistencies among previous research.

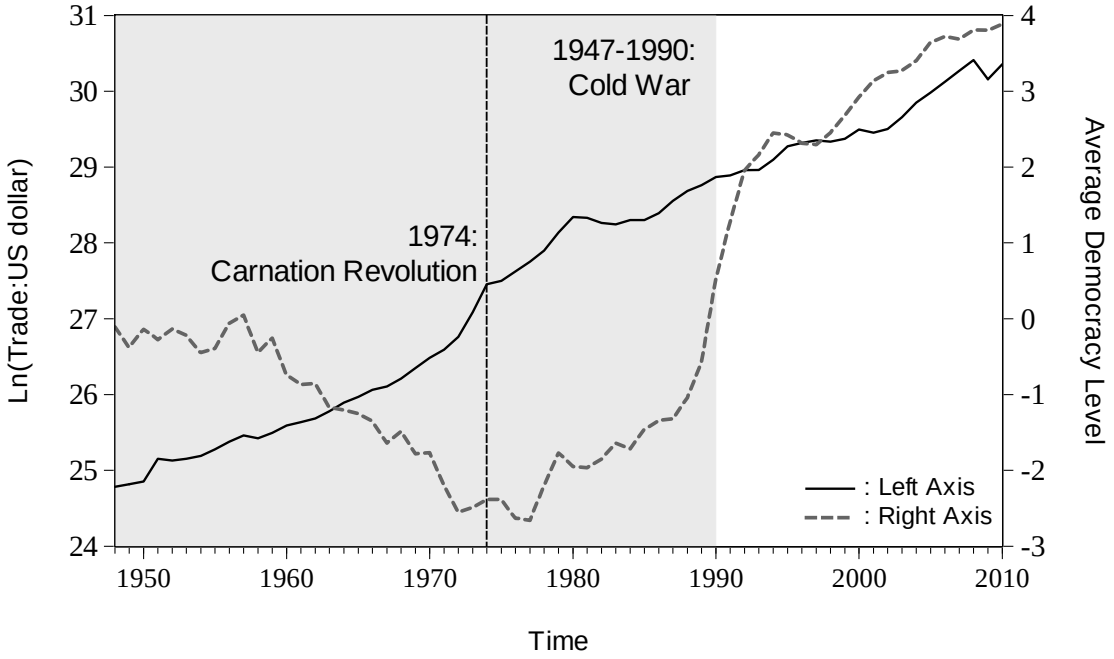

Figure 1. World trade volume and democracy levels: 1948-2010

Data source: Data on world trade volume was obtained from the WTO (World Trade Organization, http://www.wto.com/); democracy index values were obtained from the database *Polity IV* by Marshall-Jaggers (2010).

From the global trends of total export and democratization presented in Fig. 1, we can see that at the end of the 1950s, democratization began a slow decline. It was only in the mid-1970's, after the Carnation Revolution, that democratization resumed its former growth. By contrast, economic globalization appears to have increased steadily over time. However, the trends shown in the figure do not provide sufficient information to identify a relationship between democratization and economic globalization.

Between 1950 and 1990, the Cold War spread from the traditional playing field of Europe to other parts of the world. However, the volume of global trade continued to grow. Fig. 1 shows that the relationship between democratization and globalization is not fixed but varies over time. The time domain considers only the correlation coefficient, thereby producing a single time value rather than demonstrating the reality of a dynamic correlation.

In this respect, Croux et al. (2001) have proposed a spectral-based measure, the dynamic correlation, which allows one to measure the co-movement between two

series at each individual frequency. Therefore, this study used spectral-based measures to explore the dynamic relationship between democratization and globalization under different frequencies.

3. Data

The total value of exports can be used to determine the degree of economic integration and exchange; therefore more exports indicate a higher degree of economic globalization. Emulating the methods of Yu (2010), we used world merchandise exports as a measure of economic globalization. The averaged sum of the democratic globalization index was used as a measure of the global extent of democratization. This study obtained its data on world merchandise exports as global trade volume (US dollar at current prices) from the World Trade Organization (WTO); the democracy index (ranging from -10 to 10) was obtained from the database *Polity IV* by Marshall-Jaggers (2010), covering the period from 1948 (77 countries) to 2010 (for 164 courtiers).

4. Methodology

The coefficient used to express the correlation between two series has two major flaws. First, portraying the intensity of a relationship as a fixed value is problematic as relationships may vary with time. Second, correlation coefficients do not take into account the duration of the relationship's influence on fluctuations. Wavelet analysis addresses these two limitations. Wavelets analysis is localized on both a time and frequency scale. Continuous wavelet transform is used to deconstruct a continuous time function $\psi(t)$ into numerous daughter wavelets or simply wavelets $\psi_{\tau,s}(t)$. Wavelets provide a convenient and efficient way of representing complex variables or signals, as wavelets can separate large portions of data into different frequency components.

It differs from Fourier Transform in that the wavelets can be converted into a time-frequency signal with strong localization of time and frequency domains. They are especially useful where a variable or signal lasts for a finite time, or shows markedly different behavior in different time periods. The wavelets solve the problem encountered in conventional signal analysis, which is unable to simultaneously consider both time and frequency domains.

This section describes the method of wavelet analysis. If the function $\psi(t)$ satisfies the following admissibility condition:

$$0 < C_{\psi} = \int_{0}^{+\infty} \frac{\left|\psi^{*}(\omega)\right|^{2}}{\omega} d\omega < +\infty \quad (1)$$

The function $\psi^{*}(\omega)$ is chosen to be the Fourier transformation of $\psi(t)$:

$$\psi^{*}(\omega) = \int_{-\infty}^{+\infty} \psi(t) e^{-i\omega\tau} dt \quad (2)$$

then function $\psi(t)$ is called the mother wavelet from which wavelet $\psi_{\tau,s}(t)$ is derived by scaling and translation. The most commonly used mother wavelet is the Morlet wavelet and is defined as

$$\psi(\omega) = \pi^{-\frac{1}{4}} e^{i\omega_0 t} e^{-\frac{t^2}{2}} \quad (3)$$

Parameter ω_0 denotes the central frequency of the wavelet. We set ω_0=6, which is often used in economic applications (Aguiar-Conraria et al., 2008; Rua and Nunes, 2009). Wavelet transformation involves deconstructing time series into wavelets and using the wavelets to process problems of time and frequency domains. A continuous wavelet is shown below:

$$\psi_{\tau,s} = \frac{1}{\sqrt{s}} \psi\left(\frac{t-\tau}{s}\right) \quad (4)$$

where translation parameter τ is the time position, and dilation parameter s is the scale. The time shift parameter τ and scale parameter s are respectively used for translation and scaling of the wavelets, to obtain the time and scaling positions of the time series. $\frac{1}{\sqrt{s}}$ is a normalization factor to ensure unit variance of the wavelet. Wavelet transformation deconstructs the time series into different time – frequency scales. The continuous wavelet transform of the time series $x(t)$ is shown in the equation below:

$$W_x(\tau, s) = \int_{-\infty}^{+\infty} x(t) \overline{\psi}_{\tau,s}(t)\, dt = \frac{1}{\sqrt{s}} \int_{-\infty}^{+\infty} x(t) \overline{\psi}\left(\frac{t-\tau}{s}\right) dt \quad (5)$$

where $\overline{\psi}$ denotes the complex conjugate of ψ.

Wavelet transform coherence (WTC) is a method originally introduced for analyzing the transient dynamic correlations and phase lag between two time series as a function of both time and frequency (Chang and Glover 2010). Torrence and Compo

(1998) defined the cross wavelet transform (XWT) which captures the covariance between two series in the time–frequency space. Given two time series $x(t)$ and $y(t)$, with wavelet transforms $W_x(\tau, s)$ and $W_y(\tau, s)$, the cross wavelet transform is defined as $W_{xy}(\tau, s) = W_x(\tau, s)\overline{W}_y(\tau, s)$. Wavelet coherency is used to measure the localized correlation between $x(t)$ and $y(t)$ in the time-frequency space. Complex wavelet coherency $\rho_{xy}(\tau, \mathrm{s})$ is defined as follows:

$$\rho_{xy}(\tau, s) = \frac{\Re\left(W_{xy}(\tau, s)\right)}{\sqrt{\left|W_x(\tau, s)\right|^2 \left|W_y(\tau, s)\right|^2}} \tag{6}$$

where $\Re$ denotes the real part of the cross-wavelet spectrum which measures the contemporaneous covariance. Complex wavelet coherency (ρ_{xy}) measures the correlation of each time point in two time series under different frequencies. It can therefore be used to analyze the co-movement intensity of two time series under different frequencies and the variation in this intensity over time. A wavelet squared coherency ($\rho_{xy}^2 ; 0 \le \rho_{xy}^2 \le 1$) of a high value shows a strong dependence between two economic time series while a low value indicates a weak dependence. A graph plotting wavelet squared coherency therefore highlights regions in the time–frequency space where our two time series, democracy and globalization, co-vary. This kind of representation effectively captures both time- and frequency-varying features, providing refinement in dependency analysis.

5. An Empirical Result

The three dimensions of a wavelet-based measure of co-movement are best represented by a contour plot, in which the horizontal axis represents time and the vertical axes represent frequency and co-movement intensity, respectively. To facilitate ease of interpretation, frequency has been represented as time units (years) on the left axis. The gray scale is for the wavelet-based measure whereas increasing darkness corresponds to an increasing value and imitates height in a surface plot. Hence, through the inspection of the graph one can identify both frequency bands (in the vertical axis) and time intervals (in the horizontal axis) where the series move together. A dark area at the bottom (top) of the graph means strong co-movement at low (high) frequencies whereas a dark area side denotes strong co-movement of the sample period.

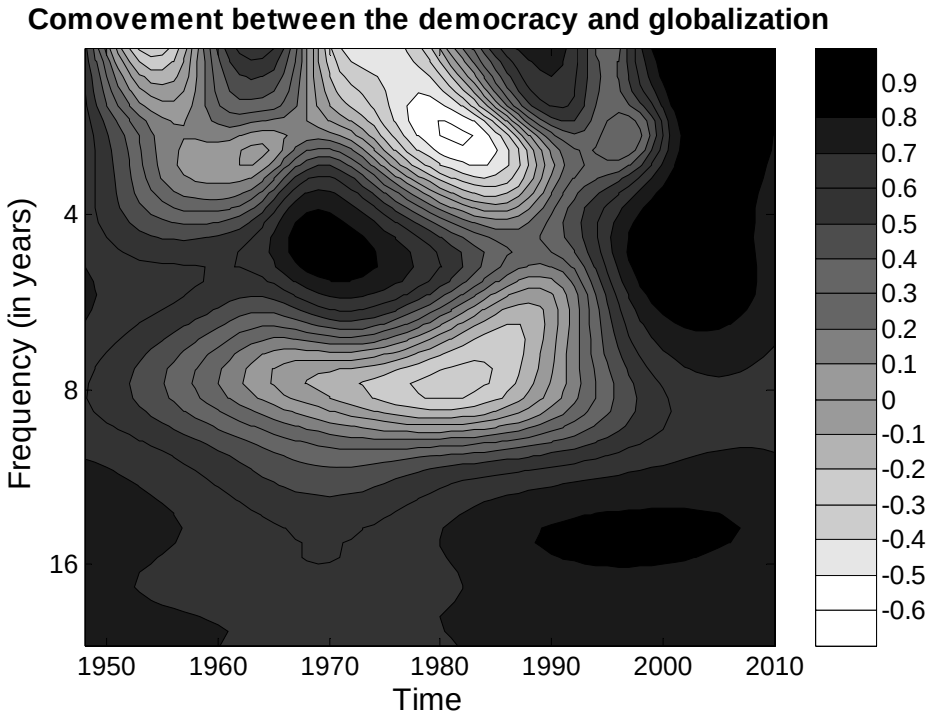

Figure 2. Wavelet coherency (ρ_{xy}) of the democracy and globalization: 1948-2010

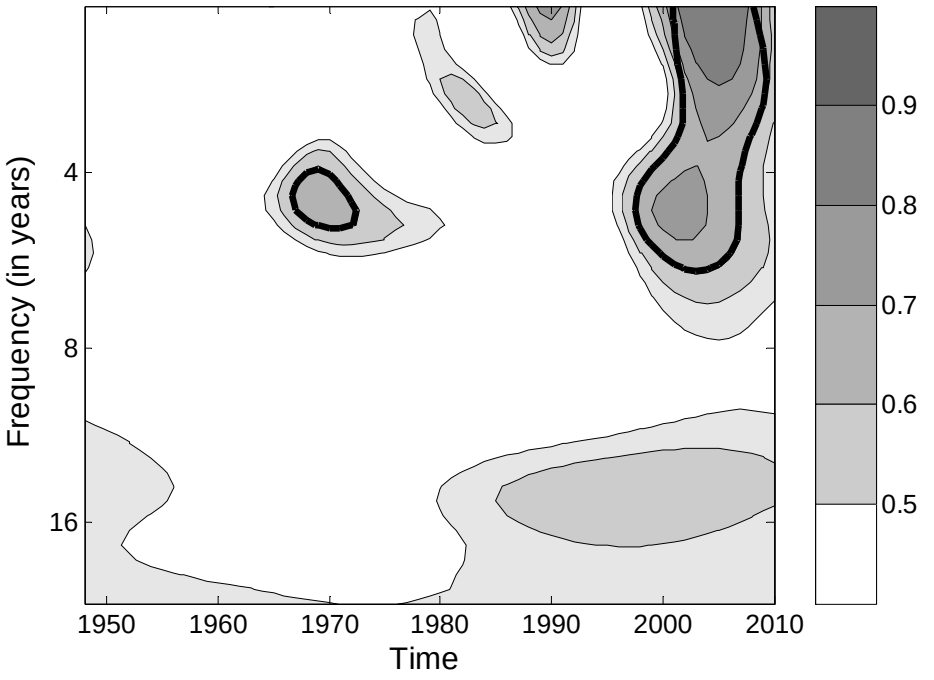

Figure 3. Wavelet squared coherency (ρ_{xy}^2) of the democracy and globalization: 1948-2010

Moreover, through such wavelet analysis one can also assess if the co-movement has increased or decreased over time and across frequencies capturing possible

varying features in the relationship between globalization and democratization in the time-frequency space. Hence, by inspecting the contour plot one can identify both frequency bands (in the vertical axis) and time intervals (in the horizontal axis) where the series move together and assess if the strength of the co-movement changes across frequencies and over time.

Fig. 2 and Fig. 3 demonstrate the following:

1) In general terms, lower frequencies (i.e., long-term fluctuations) indicate a high degree of positive co-movement.
2) Strong short-term and mid-term negative co-movement was found to exist from 1950 to 1990, except significantly positive and short mid-term co-movement during 1960-1970.
3) Post-1990 demonstrated significantly positive long-term, mid-term and short-term co-movement.

The black bold line in Fig. 3 delimits the statistically significant area at a significance level of 5%, i.e., the wavelet squared coherency (ρ_{xy}^2) is statistically significant within this bounded time–frequency area. By using Matlab to perform the necessary calculations, the 5% significance level was determined from a Monte Carlo simulation of 10,000 sets of two time series with the same length as the series under our analysis. All computations have been performed on Matlab. Figure 3 depicts the wavelet squared coherency between globalization and democratization. Analogous to the plot for Fig. 2, we show that the fluctuations at the medium to long-term frequencies are very weak for the entire sample period.

In Fig. 3, we can see that for most of the period the relationship between the two is ambiguous and insignificant under short, mid-, and long term analysis. However, between the 1960s and the 1970s, significant short mid-term co-movement occurred, and after the end of the 1990s, significant co-movement occurred in the short-term to mid-term, indicating that the Carnation Revolution in 1974 and the end of the Cold War in the 1990s were indeed major events influencing the co-movement of democratization and globalization. Global trade volume has observed a continual growth from 1948 until 2010, with an increase during that period from USD 58 billion to USD 1500 billion. It appears that almost all countries around the globe have adopted outward-oriented policies. Co-movement observed in the 1970s, and again after the 1990s demonstrates that the relationship between economic globalization and democratization was demonstrated more clearly with the Carnation Revolution and

the end of the Cold War.

The relationship between democratization and globalization is not therefore merely a positive or negative relationship, but evolves over time (time-varying), and the duration of each era (frequency) also impacts the relationship in different ways. The cause of this change, inferred from the time displayed in Fig. 2 and Fig. 3, shows that the relationship between the two is indeed associated with the Cold War. In addition, positive comovement of economic globalization and democratization is seen only when democratic politics are developed in a stable manner.

6. Conclusion

Time-domain-based co-movement analysis does not consider that the correlation between globalization and democratization is dependent upon time and frequency. Previous studies of co-movement have failed to consider how correlation varies with time under different frequency scales, leading to contradictory findings. To overcome these limitations, this study analysed the co-movement intensity of globalization and democratization under different frequencies and the changes in this intensity over time. There are few contributions to economics that use wavelets in the existing literature (Crowley, 2007); furthermore, there are relative scarce research focused on the relationship between democratization and economic globalization by using wavelets analysis. Changes in the global economy and political environment have generated a variety of shocks causing dynamic co-movement between democratization and globalization.

Therefore, we use wavelet coherency analysis in frequency domain developed by Rua and Nunes (2009) and Rua (2010) to analyse the co-movement intensity of globalization and democratization under different frequencies over time. This study attempts to address this limitation through the use of a wavelet-based approach.

Analysis of data from 1948 to 2010 demonstrated that high short-term and mid-term negative co-movement existed during 1950-1990, and that this negative trend peaked in the 1980s. Following the end of the Cold War in 1990, the mutual growth of democratization and globalization produced highly positive co-movement. These results suggest that the Cold War influenced the interaction between democratization and globalization, resulting in a negative relationship between the two forces under the period of influence. The results show that during the Cold War, the confrontation between democracy and communism caused the globalization and democratization of economy to deviate from each other. A brief interlude in which globalization and democratization advanced in parallel was caused by the Carnation

Revolution, which occurred in 1974 in this period. It is therefore only when nations around the world can put aside their differences and cooperate without conflict that economic integration and democracy can be promoted together.

References

Aguiar-Conraria, L., Azevedo, N. and M.J. Soares (2008) "Using wavelets to decompose the time-frequency effects of monetary policy" *Physica A* **387**, 2863-2878.

Barro, R.J. (1996) "Democracy and growth" *Journal of Economic Growth* **1**, 1-27.

Barro, R.J. (1999) "Determinants of democracy" *Journal of Political Economy* **107,** 158-183.

Boix, C. (2003) Democracy and Redistribution, Cambridge University Press: New York.

Bussmann, M. (2002) "Examining Causality Among Conflict, Democracy, Openness, and Economic Growth" Unpublished Manuscript, University of Alabama.

Chang, C. and G.H. Glover (2010) "Time-frequency dynamics of resting-state brain connectivity measured with fMRI" *NeuroImage* **50**, 81-98.

Croux, C., Forni, M. and L. Reichlin (2001) "A measure of co-movement for economic variables: theory and empirics" *Review of Economics and Statistics* **83**, 232-241.

Crowley, P. (2007) "A guide to wavelets for economists" *Journal of Economic Surveys* **21**, 207-264.

Dailami, M. (2000) "Financial Openness, Democracy, and Redistributive Policy" Policy Research Paper **2372**.

Decker, J.H. and J.J. Lim (2009) "Democracy and trade: An empirical study" *Economics of Governance* **10**, 165-186.

de Vries, M.S. (2001) "The attack on the state: a comparison of the arguments" *International Review of Administrative Sciences* **67**, 389-414.

Dreher, A. (2006) "Does globalization affect growth? Evidence from a new index of globalization" *Applied Economics* **38**, 1091-1110.

Eichengreen, B. and D. Leblang (2007) "Democracy and Globalization" NBER working papers number **12450**.

Feenstra, R. and G. Hanson (1996) "Foreign Investment, Outsourcing, and Relative Wages" in *Political economy of trade policy: Essays in honor of Jagdish Bhagwti* by Feenstra, G., Grossman, M., Irwin, D. A. Eds., MIT Press.

Frankel, A. and D. Romer (1999) "Does trade cause growth?" *American Economic Review* **89**, 379-399.

Garrett, G. (1998) Partisan Politics in the Global Economy, Cambridge: Cambridge University.

Li, Q. and R. Reuveny (2003) "Economic globalization and democracy: an empirical analysis" *British Journal of Political Science* **33**, 29-54.

Lipset, S. M. (1981) *Political Man: The Social Bases of Politics*, Baltimore: The

Johns Hopkins University Press.

López-Córdova, J.E. and C.M. Meissner (2005) "The Globalization of Trade and Democracy, 1870-2000" NBER working papers **11117**.

Marshall, M.G. and K. Jaggers (2010) *Polity IV Project*, data set available at http://www.cidcm.umd.edu/inscr/polity.

Milner, H. and K. Kubota, (2005) "Why the move to free trade? Democracy and trade policy in the developing countries" *International Organization* **59**, 157-193.

O'Rourke, K. and A.M. Taylor (2006) "Democracy and protectionism in the nineteen century" NBER working papers **12250**.

Patti, D.M.A. and P. Navarra (2009) "Globalization, democratization and economic growth" *Applied economics letters* **16**, 731-724.

Quinn, D.P. (2001) "Democracy and International Financial Liberalization" Unpublished manuscript, Georgetown University.

Rigobon, F. and D. Rodrik (2004) "Rule of Law, Democracy, Openness, and Income: Estimating the Interrelationships" NBER working papers **10750**.

Rodrik, D. (2000) "Institutions for High-Quality Growth: What They Are and How to Acquire Them" CEPR discussion paper **2370**.

Rose, A.K. (2004) "Do we really know that the WTO increases trade?" *American Economic Review* **94**, 98-114.

Rua, A. (2010) "Measuring co-movement in the time-frequency space" *Journal of Macroeconomics* **32**, 685-691.

Rua, A. and L.C. Nunes (2009) "International co-movement of stock market returns: A wavelet analysis" *Journal of Empirical Finance* **16**, 632-639.

Tavares, S.C. (2007) "Democracy and Trade Liberalization" working paper, Rochester Institute of Technology, February.

Torrence, C. and G.P. Compo (1998) "A practical guide to wavelet analysis" *Bulletin of American Meteorological Society* **79**, 61-78.

Yu, M. (2010) "Trade, democracy, and the gravity equation" *Journal of Development Economics* **91**, 289-300.