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CAPITAL FLOWS AND ECONOMIC GROWTH ACROSS SPECTRAL FREQUENCIES: EVIDENCE FROM TURKEY

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Capital flows and economic growth across spectral frequencies: Evidence from Turkey

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Abstract

In this paper we study the interactions and feedbacks between three categories of net capital flows and growth in the Turkish economy for the 1992:01-2009:01 period using frequency domain techniques. Our main spectral analysis tool is a new version of the causality test of Geweke (1982) and Hosoya (1991) in the frequency domain developed by Breitung and Candelon (2006). Besides, we make use of other tools of spectrum analysis such as cospectrum, squared coherence, phase and gain spectrums to decompose total covariance between capital flows and growth across main frequency bands and capture lead/lag interactions between them. Some of our empirical findings are as follows: Variance decompositions over frequency bands reveal that variations in individual capital flow categories are concentrated over high (seasonal) frequencies. We found no feedback from short-term and long-term 'other' investments to growth in these frequencies. However, there are highly significant feedbacks from growth to short-term and long-term capital inflows over business cycle and seasonal frequencies. Spectral variance decompositions reveal that, in general, percentage of variation in capital flows due to economic growth is much higher than the percentage of variation in growth due to capital flows.

JEL Classification: C32, F21, F32, F43,

Keywords: Capital flows, causality in frequency domain, Geweke's measure of feedback, Turkey

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1. Introduction

In recent years record levels of foreign capital inflows to developing economies have sparked a renewed interest in the benefits and dangers of financial openness. Following the natural policy prescription of the economic theory which suggests that financial liberalization is the "new engine of growth" (Gourinchas and Jeanne, 2006), many countries have lifted restrictions on capital account beginning especially in the late 1980s. Moreover, the controversy on the desirability of unfettered international capital flows is far from settled.

Broadly speaking, there are two views on the desirability of financial liberalization. The first one, so-called allocative efficiency argument, relies on the neoclassical (Solow) growth model in which capital inflows facilitate efficient allocation of international resources. Capital-scarce developing countries will benefit from resource flows from capital-abundant countries as these flows will contribute to investment and economic growth directly by reducing the cost of capital. Capital inflows, either in the form of foreign direct or portfolio investments, will also have long term indirect effects on economic performance through encouraging regulatory and institutional reforms to attain financial deepening, enhanced human capital, and increased competition. A recurrent theme in the financial openness literature is that the main gains from financial integration do not directly derive from transfer of capital from rich to poor countries, instead they derive from the contribution of financial integration to the quality of institutions in the recipient countries (e.g., Kenen, 2007; Mishkin, 2009; Levine, 2001). These contributions include improvements in corporate governance, the quality of banking supervision and the deepening of financial markets.

The second view stresses frequent financial instability and economic crises caused (or amplified) by international capital flows as illustrated by 1994 Mexican and 1997 Asian crises (e.g., Stiglitz (2000), Rodrik (1998)). It is argued that the undesirable macroeconomic consequences such as local currency appreciation, asset price bubbles, rapid monetary expansion and inflationary pressure, consumption boom, widening current account deficits, growing external indebtness of private sector, increasing vulnerability to external shocks, etc., have a potential to annihilate the benefits of capital inflows as a complement to insufficient domestic savings. Mishkin (2005) emphasizes that capital inflows can potentially lead to domestic lending booms by banks together with excessive risk taking which in turn leads to huge loan losses and deterioration of balance sheets of financial institutions. He argues that as an integral part of financial globalization capital flows can lead to economic growth and reduced poverty in developing countries if countries manage the process properly.

Another source of instability that may arise in a fully liberalized emerging economy is a currency or a balance of payments crisis taking place simultaneously with capital flow reversals -the socalled “sudden stop” phenomenon which has been observed in several recent financial crises. Following the works of Calvo (1998) and Calvo and Reinhart (1999) several studies offered theoretical and empirical links between sudden stops and economic growth. As mentioned in Kaminsky (2006) sudden stops can be classified as a distinct type of crisis. Her empirical analysis indicates that the adverse impact of sudden stops on output is much more pronounced for countries with fragile economies. In an attempt to distinguish the output costs of currency crises, capital account reversals and sudden stops, Hutchison and Noy (2006) find that sudden stops have a negative and much larger impact on output than other forms of currency attacks.[1]

The controversy surrounding unfettered capital inflows centers on whether benefits outweigh costs in the long run. Although positive contribution of foreign direct investments on economic growth is firmly established in the literature, there is still an ongoing debate associated with growth effects of other short and long-term capital flows including portfolio investments, bank and non-bank borrowings from abroad.

The purpose of this paper is to contribute to this debate by examining interactions and feedbacks between private capital inflows and growth in a small open emerging economy using spectral analysis techniques. We use monthly time series data from Turkish economy for the 1992:01-2009:01 period. Turkey is an interesting case study to examine the links between capital inflows and economic growth in several respects. First, following the full liberalization of capital account in 1989 Turkey has attracted significant amount of mostly short-term easily reversable financial flows. Second, as mentioned in Celasun, Denizer and He (1999), unlike many other emerging market economies Turkey has not undertaken fiscal and structural reforms before opening its capital account. This increased the fragility of already unstable economy with chronic fiscal deficits and high inflation rates in the 1990s. Third, economic growth phases closely follows periods of capital flow surges. During the financial liberalization period Turkey experienced severe capital reversals in two financial crises in 1994 and 2001. Only after the 2001 crisis Turkey implemented widespread structural

[1] Their empirical analysis relies on a panel data from 24 emerging markets over the 1975-1997 period and estimates indicate approximately 13-15% output loss which is much larger than the ouput loss in currency crises without capital outflows.

reforms in financial and banking sectors and attained a relatively sound macroeconomic environment.

In this paper we attempt to provide empirical evidence on the short-run and long-run causality between capital inflows to Turkey and economic growth by taking into account their behavior at different frequency bands. To this end, we employ a new version of the causality test of Geweke (1982) and Hosoya (1991) in the frequency domain developed by Breitung and Candelon (2006). A time series consists of both high and low-frequency components and the extent and direction of causality can differ between frequency bands (Granger and Lin, 1995). Spectral Granger-causality tests enable us to determine at which frequencies one time series causes (or helps predict) another so that we may distinguish between short-run and long-run impacts of various components of capital inflows on growth. Using Breitung and Candelon frequency domain causality test, we will obtain information about the predictive contents of the three categories of capital inflows, namely, *portfolio investments, short* and *long term* '*other*' *investments*, on economic growth. In addition, we make use of bivariate spectral analysis tools to determine the sign of feedbacks and lead-lag relationships between variables. We followed Geweke's (1982) original approach to estimate the percentage of total variations in growth due to capital flows' shocks over frequencies $\omega \in [0, \pi]$.

The paper is organized as follows. Next section provides a concise summary of recent empirical literature on the correlation between capital inflows and economic growth. Section 3 gives a brief summary of Turkey's recent experience with capital inflows. Section 4 defines the data. Empirical analysis presented in Section 5 and Section 6 concludes.

2. Capital Inflows and Economic Growth: Recent Empirical Literature

Empirical evidence on the relationship between financial openness and real economic variables is mostly based on cross-sectional or panel country studies. The evidence, however, is rather mixed: depending on the measure of financial openness, the set of control variables and countries included in cross-section or panel regressions, the choice of the sample period and the econometric methodology, several studies have reached opposing conclusions.[2]

In one of the early studies on the question of whether financial deregulation leads to long run economic growth, Quinn (1997) develops a measure of financial openness using data from 64 countries over 1950-1994. Quinn (1997) regresses the average growth rate of per

[2] Henry (2007), Edison et al. (2002a) and Eichengreen (2001) provide critical reviews of the literature on financial openness and economic growth.

capita GDP on the change in the measure of financial openness along with several explanatory variables including initial per capita GDP, investment share, population growth, secondary school enrollment, and several other controls and dummies. His results suggest that there is a positive and significant association between financial openness and long run economic growth. Based on a panel data from 44 countries over the period 1986-1997 Reisen and Soto (2001) provide supporting evidence that FDI and equity portfolio flows have statistically significant impact on long-run economic growth.

Bekaert, Harvey and Lundblad (2001, 2005) provide empirical evidence on the positive growth effects of equity market liberalization. They find that equity market liberalization leads to an approximate 1% increase in annual real per capita GDP growth. Chanda (2005) suggests that the degree of ethnic and linguistic heterogeneity in a country, which is used as a proxy for the number of interest groups, has significant impact on the relationship between capital controls and economic growth. He finds that countries with a relatively high degree of ethnic and lingusitic heterogeneity have experienced greater inefficiencies and lower economic growth from capital controls. However, for countries with high degrees of homogeneity, capital controls actually have a net positive effect on economic growth. Overall, his results suggest that several developing countries suffered from capital controls and when running country regressions one needs to account for country-specific characteristics that may affect the way standard policy prescriptions work. Using the data of 50 countries (both developed and less-developed) for the period from 1988 to 2001, Ferreira and Laux (2008) find that openness to portfolio flows is statistically conducive to growth. For the less-developed countries, net positive inflows are strongly associated with growth, whereas for the more-developed countries, flows in both directions are associated with growth (p.20).

On the other hand there are several studies that report no or negative association of capital inflows with economic growth. In a highly cited paper, using data for a sample of 100 developed and developing countries over the period 1975-1989, Rodrik (1998) provides evidence on the view that capital account convertibility is essentially uncorrelated with long-run economic performance. Edison et al. (2002b) use data from 57 countries and a set of econometric tools that can deal with biases created in cross-country regressions. Controlling for several economic, financial, and institutional characteristics and using several measures of capital account opennes, their results do not support the hypothesis that international financial integration is positively associated with economic growth. Based on a panel data from 72 countries over the period 1985-1996, Soto (2003) find that components of capital inflows do not have explanatory power for the income growth except for bank flows. In their economic growth regressions for a set of Mediterannean countries Laureti and Postiglione (2005) find that portfolio investments have negative effect on growth but foreign direct investments do not have a significant impact. For a set of East Asian countries Baharumshah and Thanoon (2006) find that short-term capital flows (including portfolio investments) have a negative impact on both short-run and long-run economic growth whereas foreign direct investments have a positive impact. Ben Gamra (2008) finds evidence that the effect of financial liberalization on economic growth depends on the nature as well as the intensity of financial sector liberalization for a set of emerging East Asian countries. His empirical analysis suggests that capital account liberalization has a strong and significant negative effect on economic growth.

Contrary to the widely accepted opinion in the pre-Asian and Russian crises period that capital flows are generally beneficial for growth (e.g., Taylor 1996), recent studies cast doubts on the importance of capital inflows as a source of growth in developing countries. For example, Bosworth and Collins (1999) found that a dollar of capital inflows raised domestic investment by more than 50 cents on average for the period 1978-1995 and this effect is even greater for foreign direct investments (FDI). In a recent study, examining the capital flows and domestic investment relationship for sixty developing countries for 1979-1999 period, Mody and Murshid (2005) conclude that in the 1990s foreign capital stimulated less domestic investment than in the preceding decade. They emphasized the fact that much of the new wave of capital was diverted by governments into international reserve holdings or was offset by capital outflows as domestic investors diversified their portfolios and furthermore, multinational firms prefer to acquire existing assets than making new investments. Examining how openness and financial crises affect investment (not output) Joyse and Nabar (2008), based on a dynamic panel of 26 emerging markets for the period 1976-2002, conclude that in the absence of banking crisis, sudden stop events fail to have a significant impact on investment and the more open an economy to capital flows, the more severe is the impact of the banking crises on investment (p.8).

Recently, several studies have taken into account the level of financial development and the quality of financial institutions in recipient countries. As noted by Prasad, Rajan and Subramanian (2007), countries with underdeveloped financial systems are unlikely to be able to use foreign capital to finance growth because investment and consumption are largely constrained by weaknesses in the domestic financial system leading to poor utilization of foreign capital to finance growth. Their empirical analysis confirms the hypothesis that financial sector development is important.

The empirical results of Bekaert et al. (2005) also suggest that countries with relatively high-quality institutions have reached larger economic growth levels. Klein and Olivei (2008), Durham (2004) and Edwards (2001) find that the effect of capital flows and openness on growth is beneficial only for economies which are industrially and financially developed above a certain level and have enough absorbing capacity. Honig (2008), using an IV estimation framework to account for the bias created by the reverse causation in growth regressions, finds that financial liberalization has a statistically significant positive effect on growth. However, his results suggest very weak support for the hypothesis that benefits are larger in countries with high-quality financial institutions. Similarly, Arteta et al. (2001) provide weak evidence that countries with high-level of financial depth and development benefit more from financial liberalization. The degree of legal development in recipient countries can also have a significant role in explaining the relationship between financial opennes and financial development. Using a panel data from 108 countries over the period 1980-2000, Chinn and Ito (2006) find that a higher level of financial openness leads to equity market development only if a threshold level of legal development has been attained. Their findings support the view that financial openness will lead to long-run economic growth indirectly through financial deepening and increased quality of legal and institutional framework.

3. Private Capital flows to Turkey

Turkey's experience with short term foreign private capital inflows was similar to many other emerging market economies in several aspects. Capital inflows have been one of the most important sources of financing of current account and public deficits since the beginning of the 1990s. The key liberal economic reforms made in the 1980s and the full deregulation of the capital account in 1989 prepared the necessary infrastructure for opening to the international financial markets, although the liberalization of domestic markets before securing fiscal discipline and bringing inflation under control have often been criticized (Akyüz and Boratav, 2003, p.2). Mainly due to unfavorable investment climate Turkey has not been successful in attracting substantial foreign direct investments (FDI) in the past up to the year 2005 (see Table 1). Over the 1992-2004 period the sum of FDI inflows to Turkey is only US$16.2 billion which constitutes 0.7 % of GDP of the period. Due to structural reforms made after 2001 financial crisis and large privatization wave Turkey have begun to attract large foreign direct investments after 2004. The sum of FDI inflows to Turkey during 2005-7 three years period reached US$52.5 billion (3.6% of GDP).

Contrary to unsuccessful experience with FDI, in the past, Turkey has attracted substantial volume of foreign capital of other types, namely, short term arbitrage-seeking international funds or 'hot money' as generally termed. Portfolio investments have become a major source of financing of large current account deficits. In this respect, Turkey is similar to the Latin American countries rather than the East Asian countries. As can be seen from Table 1, in 1992-2007 period, the net total of foreign capital inflows outside FDI, which consists of *portfolio investments* plus *short and long term 'other' investments*' lines in the BOP sheet, amounts to US$143.4 billions or 3.9 % of the period's GDP. However, it would be more accurate to look at the total gross volume (i.e., the sum of absolute values of monthly inflows and outflows) of capital flows not the net inflows (because of cancellation of inflows and outflows each other) to assess their impact on the economy. Over the period under consideration, the sum of monthly inflows and outflows of these three categories of capital flows (last line in Table 1) has reached US$470.0 billions or 12.9% of the period's GDP. Only 30% of this amount consists of *long term 'other' capital movements*, the remaining 70% is made of short term flows. Furthermore, highly volatile nature of short term capital flows can also clearly be seen from Table 1. Large outflows are observed in *portfolio* and *short term 'other' investments* during two big Turkish financial crises (1994 and 2001), the year of Russian crisis (1998) and also in last years. During the 205-month-long sample period, 1992.1-2009.1, *short term 'other' investments*, the most volatile component of flows, change sign by 49 times, that is, the average length of a boom/bust phase is only 4.2 months. This is 5.0 months for *portfolio* and 7.3 months for *long term 'other' investments*. In 105 out of 205 months, i.e., in 51.2% of time, the net inflows of *short term 'other' investments* are negative (net outflows). This ratio is 39.5% and 20.5% for *portfolio* and *long term 'other' investments*, respectively.

The present research on the effects of capital flows on the Turkish economic aggregates is exclusively based on time-domain techniques and most of these studies mainly use impulse-response analysis derived from recursive VAR models. Kirmanoglu and Ozcicek (1999) find that capital inflows lead to an increase in economic growth and real wages. Using a VAR model Akcoraoglu (2000) finds no Granger causality from capital inflows to economic growth for the 1989.1-1999.4 period and provides evidence on adverse effects of capital inflows on capital account. Alper (2002) finds that capital inflows in Turkey, especially long-term capital inflows, are strongly procyclical with real output and lead the cycle by one quarter. Using Turkish monthly data from 1992:01 to 2001:06, Berument and Dincer (2004) find that positive innovations in capital inflows appreciate domestic currency, and increase output and money supply, but decrease interest rates and prices in the short run. They also argue that the exchange rate regime does not influence the effects of capital flows on macroeconomic performance. Cimenoglu and Yenturk (2005) argue that a surge in capital flows helps the economy grow as a whole, by triggering private consumption demand first and eventually leads to a rise in investment into nontradable sector which has a limited foreign exchange generating capacity. Hence, capital flows changing domestic relative prices in favor of nontradable goods cause real appreciation of the domestic currency. Then, not sustainable large capital inflows eventually end up in economic crises.

Table 1. Annual net capital inflows to Turkey[1], US$millions, 1992-2008

Years	(1) PORT	(2) STCINF	(3) LTCINF	(4) FDI[2]	(5) NEAO[3]	(6) TCINF[4]	(7) CAD[5]	(8) FAB[6]	(9) Δ OR[7]	TCINF(6) /GDP (%)	CAD(7) /GDP (%)
1992	2,411	1,341	507	844	-1,190	3,913	-974	2,164	-1,484	2.96	-0.74
1993	3,917	2,850	2,655	636	-2,162	7,896	-6,433	8,595	-314	5.55	-4.52
1994	1,158	-5,305	931	608	1,832	-776	2,631	-4,463	-625	-0.75	2.54
1995	237	3,534	597	885	2,432	7,685	-2,339	-93	-5,032	5.53	-1.68
1996	570	2,602	2,552	722	1,499	7,945	-2,437	938	-4,545	5.54	-1.7
1997	1,634	-57	5,268	805	-987	6,663	-2,638	3,625	-3,316	4.51	-1.79
1998	-6,711	1,393	4,989	940	-713	-102	2,000	-1,287	-216	-0.06	1.18
1999	3,429	1,016	2,409	783	1,302	8,939	-925	-377	-5,614	6.01	-0.62
2000	1,022	3,172	4,542	982	-2,661	7,057	-9,920	12,581	-354	3.8	-5.34
2001	-4,515	-10,897	-758	3,352	-2,127	-14,945	3,760	-1,633	2,694	-12.3	3.09
2002	-593	-1,997	2,156	1,082	-758	-110	-626	1,384	-6,153	-0.06	-0.32
2003	2,465	3,511	1,661	1,751	4,420	13,808	-7,515	3,095	-4,047	5.53	-3.01
2004	8,023	1,434	7,612	2,785	1,071	20,925	-14,431	13,360	-824	6.82	-4.70
2005	13,437	7,096	16,112	10,031	2,628	49,304	-22,088	19,460	-17,847	13.70	-6.14
2006	7,373	-10,104	28,139	20,185	-13	45,580	-32,051	32,064	-6,114	11.29	-7.94
2007	717	-3,716	33,064	22,046	1,597	53,708	-38,219	36,622	-8,032	7.84	-5.58
2008	-4,778	2,969	23,453	17,985	4,571	44,200	-41,623	37,052	1,057	5.60	-5.27
Total(net)[8]	29,796	-1,158	135,889	86,422	10,741	261,690	-173,828	163,087	-60,766		
Absolute Sum[9]	153,636	191,212	153,211	87,834	160,679						

[1] Calculated from monthly net flows.
[2] Foreign direct investments made by foreigners inside Turkey. [3] Net errors and omissions [4] Sum of the first 5 columns.
[5] Current accounts deficits [6] Financial accounts balances
[7] Changes in offical reserves calculated from the monthly changes. Minus sign (-) indicates increases in offical reserves.
[8] Calculated from monthly net flows.
[9] Volume of capital movements, i.e., sum of absolute values of monthly net flows.

Source: Authors' own calculations from the Turkish BOP data.

4. Data

Our data include industrial production index (*IPI*) and three categories of net capital inflows, *portfolio capital* (portfolio investments of foreigners in stocks and government debt instruments in Turkey) and *short and long term 'other' investments* (borrowings of Turkish private banks and non-banking private sector from abroad) to Turkey for the 1992.01-2009.01 period[3]. All data were obtained from the Central Bank of the Republic of Turkey (CBRT) data delivery system, EVD. Since there is no monthly *GDP* series, we divided monthly net capital inflows by monthly export in order to normalize them. Due to normalization by export, all three capital flows series are covariance stationary[4]. We used three alternative detrending methods to remove trend in log (*IPI*): Hodrick-Prescott (HP) filter with a smooth parameter $\lambda = 14400$ for monthly data, full length asymmetric frequency (band-pass,BP) filter (Christiano-Fitzgerald, 2003) and year-to-year growth rate. Hence, we used three alternative proxies for growth, mainly, deviations of *log IPI* from the nonlinear HP trend (*IPIDEV*), l*og (IPI)* detrended using band-pass filter (*IPIBP*) and year-to-year gowth rate of seasonally unadjusted *IPI* series, g, $g = (IPI_t - IPI_{t-12}) / IPI_{t-12}$. The plot of data is given in Figure A1 in appendix. The variables are defined as follows:

Variable Name	**Description**
growth	Three alternative proxies for growth are used: ***IPIDEV***: Deviations of log industrial production index (seasonally adjusted), *log IPI*, around non-linear trend produced by a Hodrick-Prescott (HP) filter. Smoothing parameter λ is taken as 14400 for monthly data. ***IPIBP***: Detrended *log IPI* using , full length asymmetric frequency (band-pass,BP) filter (Christiano-Fitzgerald, 2003). ***g***: Year-to-year gowth rate of seasonally unadjusted *IPI* series, $g = (IPI_t - IPI_{t-12}) / IPI_{t-12}$
PORT	Portfolio liabilities (net) line in "capital account" division of the BOP sheet under title II-B2 (measured as a fraction of exports).
STCINF	Net 'short term other investments' given in "capital account" division of the BOP sheet under title II-B3 (as a fraction of exports). Credits used by CBRT and general government (also IMF credits) are excluded.
LTCINF	Net 'long term other investments' given in "capital account" division of the BOP sheet under title II-B3 (as a fraction of exports). Credits used by CBRT and general government (also IMF credits) are excluded.
TCINF	Total of three categories, i.e., PORT, STCINF and LTCINF, as a fraction of monthly exports.

[3] We deliberately hold foreign direct investments (FDI) out of our analysis for two reasons: first, FDI inflows are negligible for before-2005 period in Turkey, second, we believe that the channels through which FDI affect growth are radically different than those of arbitrage-seeking capital movements.
[4] The results of commonly used unit root tests are not reported but available from the authors upon request.

5. Empirical analysis

5.1 Breakdown of total variance of capital flows series over main frequency bands

The breakdown of total variances of the series over main frequency bands are given in Table 2. Total variances of all three categories of net capital inflows are concentrated over the high seasonal frequencies, especially, over periodicities of 9 to 2 months. That is, the capital flows, even the subcategory which is called "*long term investments*", are mainly short term in nature. Business cycles (BC) frequencies account for only 18-20% of the total variations of capital flows series whereas 48-58% of the variance of *growth* (depending on detrending methods) comes from BC frequencies. This inherent volatility of capital flows are well documented in capital reversals (sudden stops) (Calvo ,1998; Calvo and Reinhart, 1999) and hot money literature (Stiglitz, 1999). The short term, unstable and highly speculative nature of international capital movements is one of the main sources of instability in host countries.

Table 2 Breakdown of total variance over main frequency bands

Main frequency bands (P: Periods)	Growth						
	IPIDEV	*IPIBP*	*g*	*PORT*	*STCINF*	*LTCINF*	*TCINF*
Long run trend: $P \geq 96$ *months*	0.009	0.062	0.044	0.035	0.009	0.234	0.049
BC frequencies: $18 \leq P < 96$	0.476	0.537	0.578	0.19	0.183	0.205	0.226
Seasonal freq. I $9 \leq P < 18$	0.124	0.096	0.076	0.165	0.132	0.095	0.167
Seasonal freq.II $2 \leq P < 9$	0.391	0.305	0.302	0.61	0.676	0.466	0.558
Sum	1.0	1.0	1.0	1.0	1.0	1.0	1.0

5.2 Causality test in time and frequency domains

5.2.1 Causality test in time domain

Table 3 presents results obtained from the usual Granger-causality tests in time domain between three components of *capital flows* and *growth* which is measured in two different ways: deviations of industrial production index (*IPI)* from HP nonlinear trend and year-to-year growth rate of *IPI*. We used full length asymmetric band-pass filter developed by

Christiano-Fitzgerald (2003) as an alternative detrending method, but since it produced almost the same results with the HP filter, we did not report them here. All tests are repeated for three different lag orders suggested by the AIC, SIC and HQ information criteria.

There is no causality in any direction between *growth* and *short term other investments* (*STCINF*) irrespective of the detrending method used. *Portfolio investments* (*PORT*) Granger-cause growth albeit not too strongly (with p-values of 0.05 and 0.08 for lags 2 and 4) if *IPI* is detrended using HP or frequency filters, but there is no causality if year-to-year growth rate is used. Interestingly, the direction of Granger-causality between *long term other investments* (*LTCINF*) and *growth* is from *growth* to *LTCINF*, '*growth* $\rightarrow$ *LTCINF*', no matter which growth definition is used (p-values are 0.0058 and 0.0141 for lags 5 and 15 chosen by AIC). A weak Granger-causality is observed from *LTCINF* to *growth* with a p-value of 0.09 in the second detrending case.

Table 3 Results of Granger-causality tests in time domain between growth and subcategories of capital flows

		PORT	*STCINF*	*LTCINF*	*TCINF*
IPI detrended using HP filter (*IPIDEV*)[1]	Number of lags (ℓ)	(4, 2, 3)[2]	(3, 2, 2)	(5, 2, 2)	(3, 2, 2)
	Direction of Granger-causality (GC)	$\leftarrow$ (Both at ℓ=2 and 4) (p value: 0.0517 and 0.0777, resp.)	No GC neither at ℓ=3 nor at ℓ=2	$\rightarrow$ (ℓ=5) (p value: 0.0058)	$\leftrightarrow$ (ℓ=3) (p values: 0.0251 and 0.0302 for directions $\rightarrow$ / $\leftarrow$, respectively)
Year-to-year growth rate (*g*)	Number of lags (ℓ)	(4, 2, 3)	(4, 2, 2)	(15, 2, 2)	(3, 2, 2)
	Direction of Granger-causality (GC)	No GC at ℓ=2, 3 or 4	No GC neither at ℓ=4 nor at ℓ=2	*No GC at* $\ell = 2$ $\rightarrow$ (ℓ=15) (p values: 0.0141) $\leftarrow$ (p value: 0.0868)	No GC neither at ℓ=3 nor at ℓ=2

[1] Test results are almost the same if band-pass filter instead of HP filter is used for detrending IPI.
[2] Number of lags (ℓ) selected by Akaike, Schwarz and Hannan-Quinn information criteria, respectively, in a bivariate VAR model with a constant.
Note: LM test for no residual autocorrelation up to order 6 is not rejected at 5% significance level.

It is surprising that *long term* capital flows of recent months do not have any predictive power in one-period ahead forecast of *growth*, but just the opposite is correct. Contrary to our expectation, *growth* precedes *long term* capital flows meaning that the foreign long term investors watch recent performance of the Turkish economy before taking their decisions to inflow or outflow. Granger-causality between total capital flows (sum of three categories), *TCINF*, and growth is not robust to detrending method. A bidirectional causality is observed if HP and band-pass filters are used for detrending, while there is no causality if year-to-year growth rate is used.

5.2.2 Causality test in frequency domain

Spectral Granger Causality Test:

In this section we first define Geweke's linear measure of feedback from one variable to another at a given frequency and describe the test procedure as operationalized by Breitung and Candelon (2006). Let zero mean covariance stationary time series x_t and y_t have a VAR model with finite (p) order:

$$\begin{bmatrix} \Theta_{11}(L) & \Theta_{12}(L) \\ \Theta_{21}(L) & \Theta_{22}(L) \end{bmatrix} \begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}, \tag{1}$$

where $\Theta(L)$ are lag polynomials and $\varepsilon_t = [\varepsilon_{1t}, \varepsilon_{2t}]'$ is white noise error vector with $E(\varepsilon_t) = 0$ and has a positive definite variance-covariance matrix $\Sigma = E(\varepsilon_t \varepsilon_t')$. Applying Cholesky factorization, GG = Σ^{-1} where G is a lower triangular matrix such that $\eta_t = G\varepsilon_t$ and $E(\eta_t \eta_t')$ = I, the MA representation of the stationary system in equation 1 can be written as

$$\begin{aligned} \begin{bmatrix} x_t \\ y_t \end{bmatrix} &= \Phi(L)\varepsilon_t = \begin{bmatrix} \Phi_{11}(L) & \Phi_{12}(L) \\ \Phi_{21}(L) & \Phi_{22}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}, \\ &= \Psi(L)\eta_t = \begin{bmatrix} \Psi_{11}(L) & \Psi_{12}(L) \\ \Psi_{21}(L) & \Psi_{22}(L) \end{bmatrix} \begin{bmatrix} \eta_{1t} \\ \eta_{2t} \end{bmatrix}, \end{aligned} \tag{2}$$

where $\Phi(L) = \Theta(L)^{-1}$ and $\Psi(L) = \Phi(L)G^{-1}$.

Using Fourier transforms of MA polynomial terms, the spectral density of x_t can be written as

$$f_x(\omega) = \frac{1}{2\pi}\left\{\left|\Psi_{11}(e^{-i\omega})\right|^2 + \left|\Psi_{12}(e^{-i\omega})\right|^2\right\}. \tag{3}$$

The Geweke's measure of linear feedback from *y* to *x* at frequency ω is defined as

$$M_{y \to x}(\omega) = \log\left[\frac{2\pi f_x(\omega)}{\left|\Psi_{11}(e^{-i\omega})\right|^2}\right] = \log\left|1 + \frac{\left|\Psi_{12}(e^{-i\omega})\right|^2}{\left|\Psi_{11}(e^{-i\omega})\right|^2}\right|. \quad (4)$$

If $\left|\Psi_{12}(e^{-i\omega})\right|$=0, then $M_{y \to x}(\omega)$ will be zero which means that *y* does not cause *x* at frequency ω.

Due to the absence of tractable and reliable asymptotic theory for inference about measures of feedback Geweke (1986) used parametric bootstrap to test the null hypothesis

$$\text{H}_\text{o}: \; M_{y \to x}(\omega) = 0. \quad (5)$$

Breitung and Candelon (1996) developed a new approach to test the null hypothesis in (5). Using $\Psi(L) = \Theta(L)^{-1} G^{-1}$, we can write

$$\Psi_{12}(L) = -\frac{g^{22}\Theta_{12}(L)}{\left|\Theta(L)\right|}, \quad (6)$$

where g^{22} is the lower diagonal element of G^{-1} and $\left|\Theta(L)\right|$ is the determinant of $\Theta(L)$. Since $M_{y \to x}(\omega) = 0$ when $\left|\Psi_{12}(e^{-i\omega})\right|$=0, it follows that *y* does not cause *x* at frequency ω if

$$\left|\Theta_{12}(e^{-i\omega})\right| = \left|\sum_{k=1}^{p} \theta_{12,k} \cos(k\omega) - \sum_{k=1}^{p} \theta_{12,k} \sin(k\omega) i\right| = 0. \quad (7)$$

Thus, a necessary and sufficient set of conditions for $\left|\Theta_{12}(e^{-i\omega})\right|$ = 0 is

$$\sum_{k=1}^{p} \theta_{12,k} \cos(k\omega) = 0 \quad (8)$$

$$\sum_{k=1}^{p} \theta_{12,k} \sin(k\omega) = 0 \quad (9)$$

The restriction (9) will be dropped for ω=0 and $\omega = \pi$ because *sin(k*ω*)=0* for these frequencies. Breitung and Candelon test is based on the linear restrictions (8) and (9) which can be reformulated in a VAR equation

$$x_t = \alpha_1 x_{t-1} + \ldots.. + \alpha_p x_{t-p} + \beta_1 y_{t-1} + \ldots\ldots. + \beta_p y_{t-p} + \varepsilon_{1t}, \quad (10)$$

where $\alpha_j = \theta_{11,j}$ and $\beta_j = \theta_{12,j}$. The null hypothesis $M_{y \to x}(\omega) = 0$ is equivalent to the linear restriction

$$\text{H}_\text{o}: \; R(\omega)\beta = 0, \quad (11)$$

where $\beta = (\beta_{1,....,}\beta_p)'$ and

$$R(\omega) = \begin{bmatrix} \cos(\omega)\cos(2\omega).......\cos(p\omega) \\ \sin(\omega)\sin(2\omega).........\sin(p\omega) \end{bmatrix}.$$

To test this restriction, rewrite the model in (10) as

$$x_t = \alpha' v_t + \beta' w_t + \varepsilon_{1t},$$

where $\alpha = (\alpha_1, \alpha_2, ..., \alpha_p)'$, $v_t = (x_{t-1}, x_{t-2}, ..., x_{t-p})'$, $\beta = (\beta_1, \beta_2, ..., \beta_p)'$, and $w_t = (y_{t-1}, y_{t-2}, ..., y_{t-p})'$. Let $R_\perp(\omega)$ be the orthogonal complement of $R(\omega)$ and let

$$Q(\omega) = \begin{bmatrix} R_\perp(\omega) \\ R\ (\omega) \end{bmatrix}_{pxp},$$

then the model can be written as

$$\begin{aligned} x_t &= \alpha' v_t + \beta' Q(\omega)^{-1} Q(\omega) w_t + \varepsilon_{1t} \\ &= \alpha' v_t + \beta^{*'} w_t^* + \varepsilon_{1t} \\ &= \alpha' v_t + \beta_1^{*'} w_{1t}^* + \beta_2^{*'} w_{2t}^* + \varepsilon_{1t} \qquad (12) \end{aligned}$$

where $w_{1t}^* = R_\perp(\omega) w_t$ and $w_{2t}^* = R\ (\omega) w_t$. The null hypothesis in (11) is equivalent to the restriction $\beta_2^* = 0$ which can easily be tested using the usual F test. The ordinary F statistic for (11) is approximately distributed as $F(2, T-2p)$ or χ_2^2.

Results:

Figure 1, Figure 2 and Table 4 present the results of Breitung-Candelon (2006) version of Geweke's (1982) causality tests in frequency domain. Breitung-Candelon test statistics shown in Figure 1 (panels a-d) is an equivalent of Geweke's measure of linear dependence (feedback). Since this test statistic says nothing about the sign of feedback between variables, we make use of real part of cross-spectrum, i.e., co-spectrum, $CrS_{xy}\ (\omega)$, and coherence squared, $K_{xy}^2\ (\omega)$, values of control (input) variable *x* and output variable *y* to determine the sign of feedback[5]. Here, capital flows are control variables (*x*), and growth is output variable (*y*). Figure 1 (panels $a' - d'$) shows co-spectrums and squared coherency values. The statistically significant K_{xy}^2 values at 5% level are marked by an asterisk (*). A positive (negative) and significant co-spectrum value, $CrS_{xy}(\omega)$, at frequency ω indicates that *x* and *y*

[5] See Hamilton 1994, p.270-275 for basic definitions of spectral analysis.

have pro-cyclical (counter-cyclical) common movements at this frequency. It will not be wrong to infer about the sign of feedback at any frequency ω by looking at sign of co-spectrum at the same frequency. $CrS_{xy}(\omega)$ is statistically significant if $K^2_{xy}(\omega)$ is significant for any frequency ω.

As in Granger causality tests in time domain above we used two different measures for growth: deviations from HP trend (*IPIDEV*) and year-to-year growth rate of *IPI* (g). Frequency (band-pass) filter detrending produced very similar results with HP filter in frequency domain, too. Thus, we do not present plots of test statistics associated with band-pass filter detrended growth variable. Figure 1 shows test results for *IPIDEV* and Figure 2 for year-to-year growth rate (*g*).

As can be seen in *Figure 1/a*, when HP deviations are used as a proxy for growth (*IPIDEV*), *portfolio investments* (*PORT*) Granger-cause growth at 10% level at business cycle (BC) frequencies, $0.065 < \omega < 0.35$, which correspond to periodicities from 96 to 18 months in monthly data, and at high frequancies ω>2 (two to three-month periods) at 5% level. The sign of feedback from *PORT* to *growth* is positive at BC frequencies, but negative at high frequencies around ω=2 as the sign of co-spectrum given in $Figure 1/a'$ suggests.

Table 4 Results of Breitung-Candelon (2006) causality tests in frequency domain

	Low and BC frequencies: ($\omega \in (0, 0.35)$) (Period $\geq$ 18 months)	Seasonal freq. 1: $\omega \in (0.35, 0.70)$ (Period: 18 to 9 months)	Seasonal freq. 2: $\omega \in (0.70, \pi)$ (Period: 9 to 2 months)
	IPI **detrended using HP filter *(IPIDEV)***		
PORT (lag=3 and 4)	(+)* $\rightarrow$[1]	No feedback	(-) $\rightarrow$[2]
STCINF (lag=3)	No feedback	No feedback	No feedback
LTCINF (lag=5)	$\leftarrow$ (+)	$\leftarrow$ ($\pm$)	$\leftarrow$[2] (-)
TCINF (lag=3)	(+) $\rightarrow$	(+) $\rightarrow$	$\leftarrow$ ($\pm$)
	Year-to-year growth rate (*g*)		
PORT (lag= 4 and 3)	No feedback	No feedback	No feedback
STCINF (lag=4)	$\leftarrow$ (+)	$\leftarrow$ (+)	$\leftarrow$ (+)[3]
LTCINF (lag=3 and 4)	No feedback	No feedback	No feedback
LTCINF (lag=15)	$\leftrightarrow$ (+)	$\leftrightarrow$ (+)	$\leftarrow$ (+)
TCINF (lag=3)	No feedback	No feedback	$\leftarrow$[1] (+)

* Sign of co-spectrum at the frequency under consideration.
[1] Significant at 10% level.
[2] Significant for periodicities from 3 to 2 months.
[3] Significant for periodicities from 9 to 4 months.

If year-to-year growth rate is used instead of HP deviations (*Figure 2/a*), there is no feedback between *PORT* and *growth* at any frequency. As can be seen from $Figure 1/a'$, statistically significant coherency squared values, K^2, (marked by *) are clustered around frequency ω=2, and the sign of co-spectrum, *CrS*, is negative at these frequencies. This means that *portfolio capital flows* and *growth* have common counter-cyclical seasonal co-movements with 2-3 months periodicities. Positive co-spectrum indicates pro-cyclical comovements between two variables at BC frequencies, but, since K^2s are insignificant at these frequencies, comovements are also statistically insignificant.

The feedback between *short term 'other' investments* (*STCINF*) and *growth* is not robust to growth definition. There is no feedback in any direction at any frequency when HP deviations (*IPIDEV*) are used (*Figure 1/b*), whereas a strong positive feedback from *growth* to *STCINF*, $g \rightarrow STCINF$, is observed at all frequencies except ω>1.7 (seasonal cycles with 2-3 months periods) when year-to-year growth rate of IPI is used as a proxy for economic growth (*Figure 2/b*). That is, no matter which detrending method is used, net inflows/outflows of *short term 'other' investments* (*STCINF*) realized in recent months have no explanatory power on one period ahead forecast of growth. Unlike portfolio investments, *STCINF* have strong common pro-cyclical contemporaneous comovements with growth at BC frequencies, $0.065 < \omega < 0.35$, as suggested by positive co-cpectrum and significant coherency values at these frequencies ($Figure\ 1/b'$).

A strong feedback is detected from *growth* towards to *long term 'other' investments*, *LTCINF*, which mostly consist of bank and non-bank private borrowings with maturity more than one year, both at BC and seasonal frequencies ($Figure\ 1/c$) when HP filter is used for detrending *IPI* (*IPIDEV*). When year-to-year growth rate is used (*Figure 2/c*), using appropriate number of lag as p=15 chosen by AIC, we observe a bidirectional causality, $growth \leftrightarrow LTCINF$, at frequencies ω<1.5 which include BC frequencies and seasonal frequencies with periodicity from 18 to 4 months. At high seasonal frequencies with periodicities from 4 to 2 months (ω>1.5), the direction of feedback is from *growth* to *LTCINF*. Since Breitung-Candelon (2006) test statistics follow a very unstable path over frequencies $\omega \in (0, \pi)$ for large number of lags (p), this bidirectional causality between *growth* and *LTCINF* for p=15 should be interpreted with caution. For small lags such as p=3, 4, and 5 there is no causality between these variables at any frequency.

As abundance of significant K^2s in $Figure 1/c'$ indicates, long term '*other*' investments, *LTCINF*, have stronger pro-cyclical comovements with *growth* over both BC and seasonal frequencies compared to *portfolio* and *short term 'other' investments*.

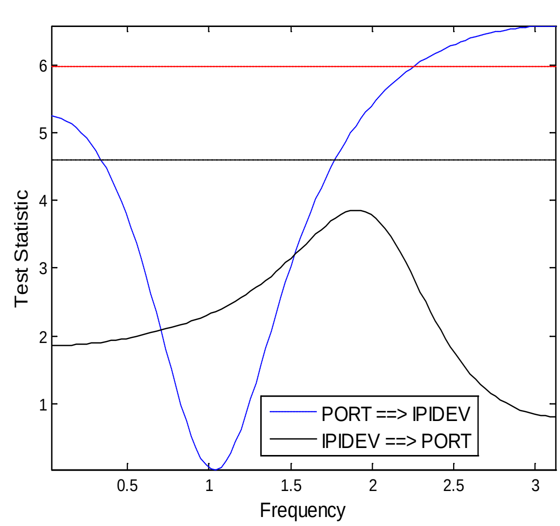
Total capital inflows, TCINF, which is the sum of three categories considered above have a positive significant feedback on *growth* defined as HP deviations at BC and seasonal frequencies with periodicities longer than 6 months, $\omega < 1.0$ (*Figure 1/ d*). For seasonal frequencies above ω=1, the direction of causality changes to '$growth \rightarrow LTCINF$'. If year-to-year growth rate is used (*Figure 2/ d*), no feedback is observed between two variables over BC and lower seasonal frequencies. A feedback which is significant only at 10% from *growth* to *LTCINF* is discovered at high seasonal frequencies with periodicities shorter than 6 months.

In summary, concentrating on BC frequencies, our findings from Breitung-Candelon (2006) bivariate causality tests in frequency domain show that, firstly, *portfolio investments* (*PORT*) either does not Granger-cause *growth* (*g*) or Granger-cause at only 10% significance level (*IPIDEV*). Secondly, there are highly significant feedbacks from *growth* towards *short* and *long term 'other' investments* (*STCINF* and *LTCINF*) although these feedbacks are not robust to growth definition. All findings support the idea that growth precedes *STCINF* and *LTCINF*, both in BC and seasonal frequencies. There is no hint to affirm the opposite case, i.e., *flows* precede *growth*.

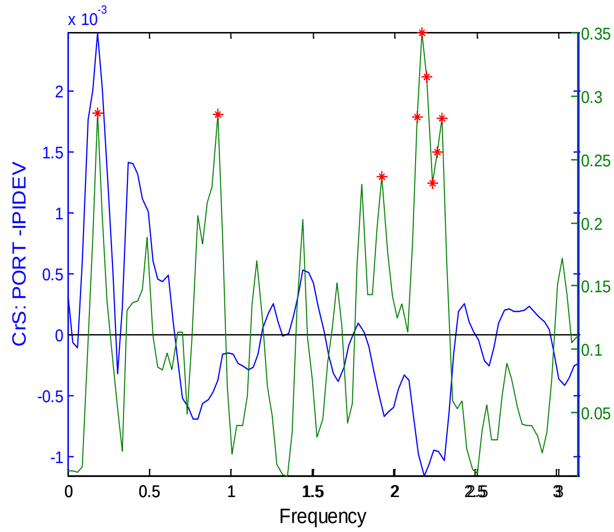
Comparing the results given in Table 3 and 4, we can easily see that the causality test in frequency domain provides us more detailed information about the feedback relationships between growth and categories of capital flows than usual test in time domain. Investigating causality over different frequency bands provides results which are radically different than those of standart Granger-causality test in time domain which can be interpreted as an average causality over all frequencies $\omega \in (0, \pi)$. For example, while we found no Granger-causal relationship between short term '*other*' investments (*STCINF*) and *growth* independent of growth definition (*IPIDEV* or *g*) used in time domain, a significant feedback is detected from growth (g) towards *STCINF* for both BC and lower seasonal frequencies in frequency domain (see, *Figure 2/ b*).

Figure 1 Granger causality tests in frequency domain: HP-filtered growth rate (a-d); Copectrums and Coherence Squareds (a'-d')

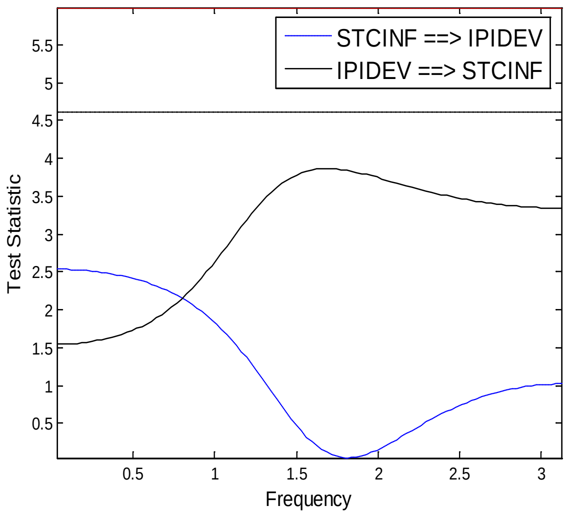
(a)



(a')



(b)



(b')

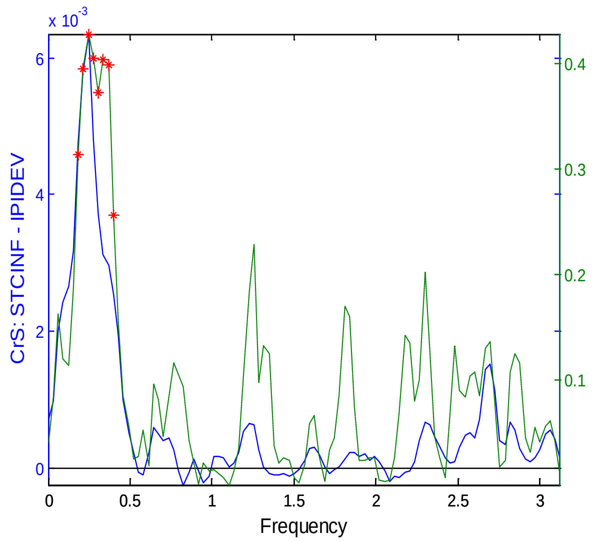
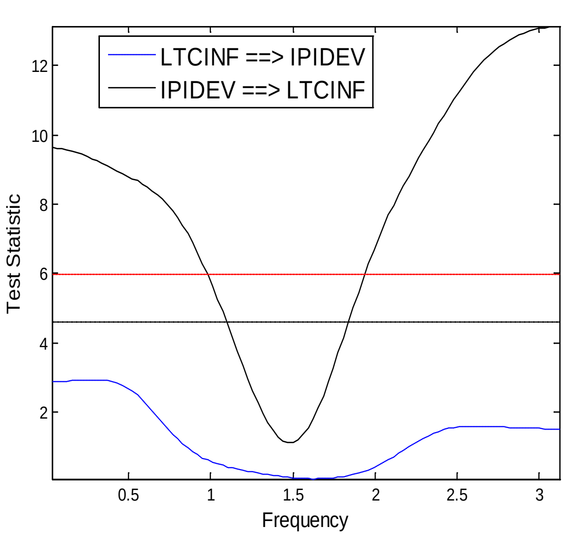
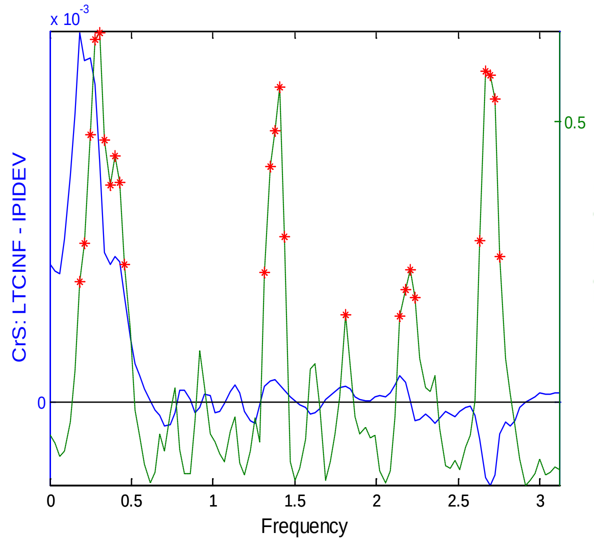


Figure 1 (continued)

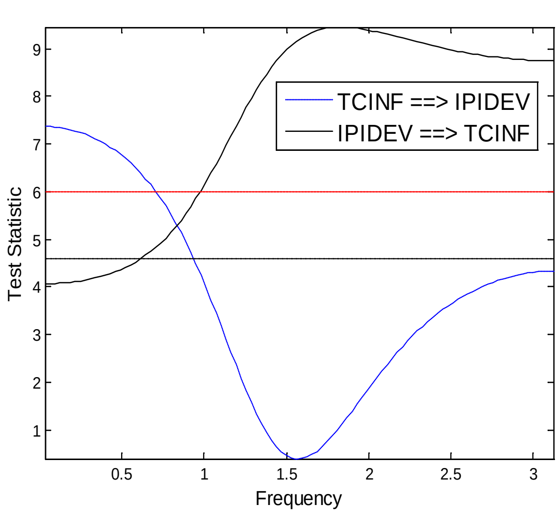
(c)



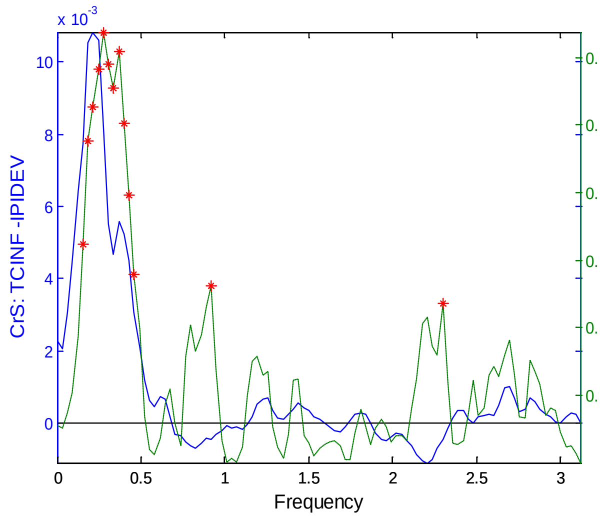
(c')



(d)



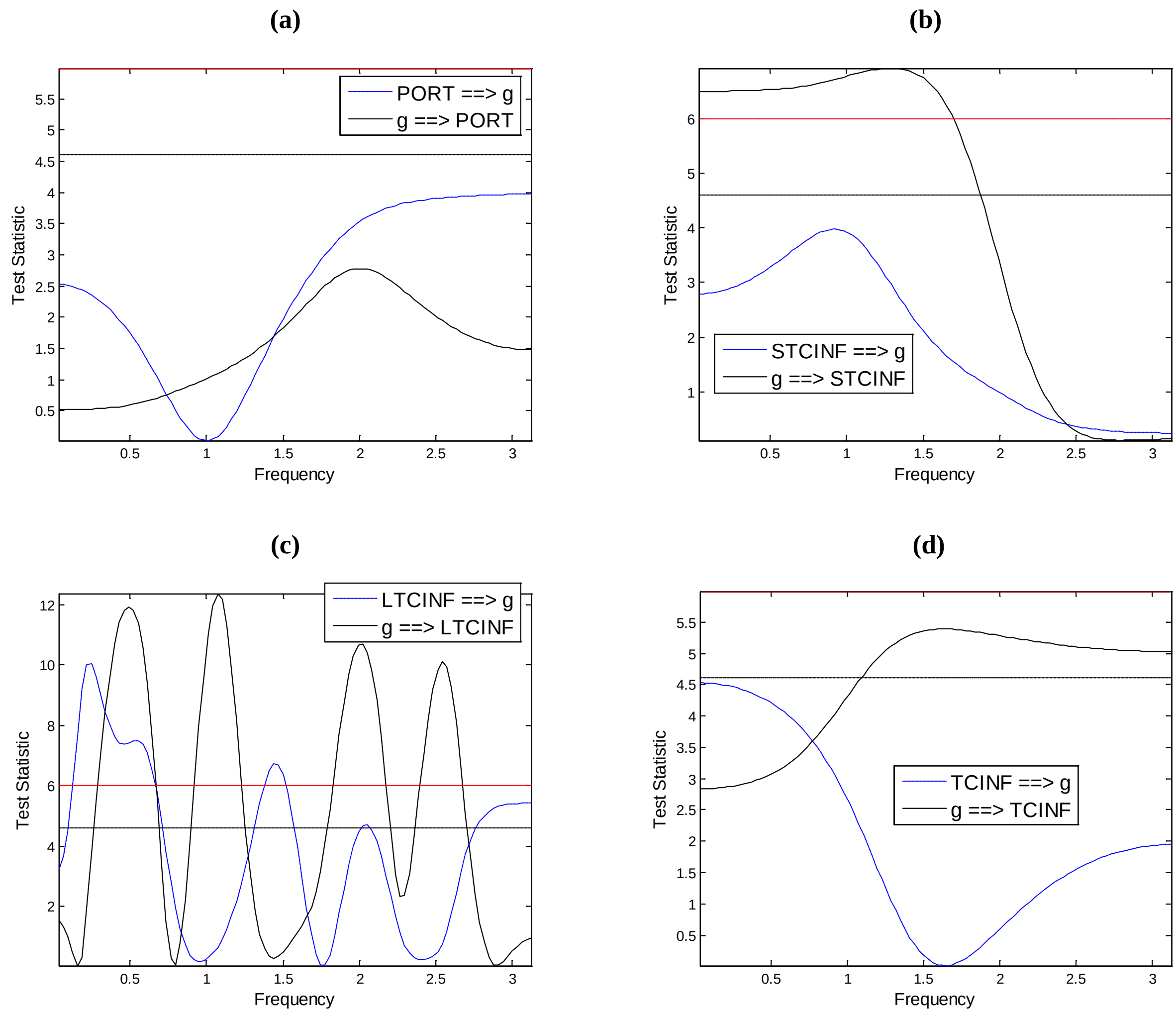
(d')



Notes: LEFT PANEL (a-d): Frequency-domain causality test results for each pair of capital inflow component and deviations of industrial production index from the HP trend (IPIDEV). Straight lines are 5% (upper) and 10% (lower) critical values. The null hypothesis is that there is no Granger-causality from one variable to another at a given frequency over (0, π). Variable definitions are as follows: PORT: portfolio inflows, STCINF: short-term capital inflows, LTCINF: long-term capital inflows, TCINF: total capital inflows.

RIGHT PANEL (a'-d'): Copectrum (line, left scale) and squared coherency (dashed line, right scale) values are displayed on the right panel. Statistically significant (at 5% level) values are shown by an asterisk.

Figure 2   Granger causality tests in frequency domain: year-to-year growth rate



Notes: Breitung and Candelon (2006) frequency domain Granger causality test results are shown for year-to-year growth rate (g) and components of capital inflows together with 5% (upper) and 10% (lower) critical values. The null hypothesis is that there is no Granger-causality from one variable to another at a given frequency over (0, π). Variable definitions are as follows: PORT: portfolio inflows, STCINF: short-term capital inflows, LTCINF: long-term capital inflows, TCINF: total capital inflows.

5.3 Capital flows and growth: Average percentage of variance explained over all frequencies

In this subsection we calculate average portion of variance of *growth* due to categories of capital flows' shocks over all frequencies, $\omega \in (0,\pi)$, from coherence squared, $K_{xy}^{2}(\omega)$, using smoothed periodograms (S_{xx}) of variables as weights. Let *x* denote *categories of net flows*, *y* denote *growth*, then, average percentage of variance of *y* attributable to *x*, V_{yx}, will be:

$$V_{yx} = \sum_{\omega=0}^{\pi} S_{xx} K_{xy}^{2} / \sum_{\omega=0}^{\pi} S_{xx} \ .$$

Using this formula, we calculated the average % of total variance of *growth* due to shocks of capital flows and average % of total variance of capital flows categories explained by growth over all frequencies $\omega \in (0, \pi)$. The results are reported in Table 5. As can be seen from the first part of Table 5, *portfolio* (*PORT*) and *short term 'other' investments* (*STCINF*) explain around 11-12% of variance of *growth* depending on the proxy used for growth over all frequencies $\omega \in (0, \pi)$. The portion of variance of *growth* attributable to *long term* '*other*' *investments* (*LTCINF*) is, to some extent higher, 15-18%. *TCINF* explains 16-18% of the variance of *growth* in average over whole frequencies.

Table 5
% of variance of growth and capital flows categories explained by each other over all frequencies $\omega \in (0, \pi)$.

% of variance of growth due to capital flows categories[1]			
	IPIDEV	*IPIBP*	*g*
PORT	11.9	11.5	10.8
STCINF	12.1	11.6	12.1
LTCINF	15.3	17.8	14.5
TCINF	18.1	17.8	16.4
	% of variance of capital flows categories due to growth		
	IPIDEV	*IPIBP*	*g*
PORT	12.6	10.0	9.6
STCINF	18.2	16.5	18.2
LTCINF	24.2	22.4	19.2
TCINF	27.1	24.0	24.0

[1] Since entries are estimated from coherency squared, K_{xy}^{2}, values derived in a bivariate frame, the % of variance of growth attributable to capital flow categories are not summable.

The second part of Table 5 gives the portions of total variance of *capital flow* categories assignable to *growth* over all frequencies $\omega \in (0, \pi)$. It is interesting to observe that, with the exception of *portfolio investments* (*PORT*), % of variance of flows explained by *growth* is much higher than % of variance of *growth* due to *capital flows* given in the first part of Table 5. The portion of variance explained by *growth* is 17-18% for *STCINF*, 19-24% for *LTCINF* and 24-27% for sum of three categories (*TCINF*). Considering these findings together with the results of causality tests in frequency domain indicating the direction of feedback as '*growth* (*g*)$\rightarrow$*STCINF*' and '*growth* (*IPIDEV*) $\rightarrow$*LTCINF*' (see, Table 4), we can infer that it is growth that drives capital flows, not the reverse, in Turkish case. Economic growth precedes flows. In other words, foreign investors follow Turkish business cycles closely and make their decision to inflow or outflow according to their animal spirits about changing business conditions in the economy. Recovery (recession) does not begin thanks to *capital inflows* (*outflows*), but inflows (*outflows*) occur because investors feel that the recovery (recession) already has begun.

5.4 Gain Spectrums: Contemporaneous impacts of flows on growth

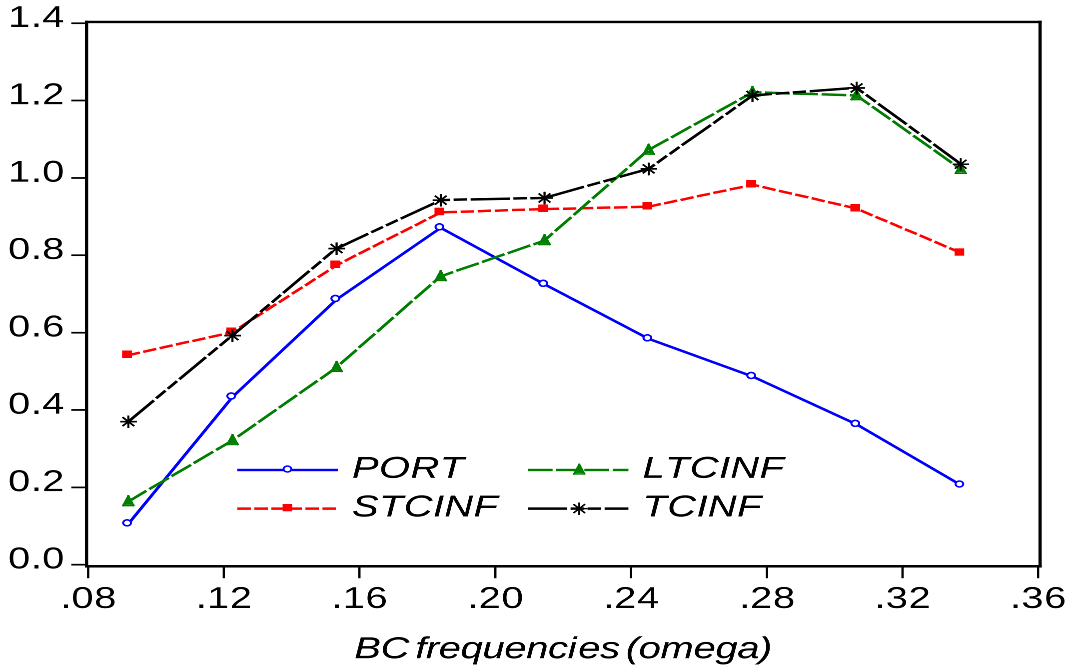
Figure 3 presents gain spectrums, $G_{xy}(\omega)$, of growth (*y*) and net capital inflows (*x*) over business cycles (BC) frequencies, $0.065 < \omega < 0.35$, which correspond to periodicities between 96 to 18 months (NBER classification). Gain shows the impact of input (control) variable *x* on output variable *y* at each frequency, $\omega \in (0, \pi)$ and it is equal to $\left|A_{xy}(\omega)\right| / S_{xx}(\omega)$ where A_{xy} is cross-amplitude and S_{xx} is power spectrum of *x*. Gain, $G_{xy}(\omega)$, is equivalent to the absolute value of slope coefficient $\beta(\omega)$ at frequency ω of the following band-spectrum regression between *y* (dependent variable) and *x*:

$$y^*(\omega) = \beta(\omega) x^*(\omega) + \varepsilon^*(\omega)$$

where y^* and x^* are Fourier transformations of standardized (i.e., $x = (X - \bar{X}) / \sigma_X$) time series variables *y* and *x*.

As one can see from Figure 3, gains follow a $\cap$-shaped pattern. Portfolio investments (*PORT*) have maximum impact on growth at ω=0.18 (period=34 months) with a gain coefficient of 0.85. That is, one σ-increase in *PORT* ratio is associated with 0.85σ-increase in *growth* in their common 34-month-long cycles. Since their cospectrum is positive at this frequency (see, *Figure 1/a'*), the sign of gain at the same frequency is also positive. *STCINF* and *LTCINF* have largest contemporaneous impact on growth at ω=0.28 (period=23 months) and ω=0.30 (period=20 months) with gain coefficients of 1.0 and 1.2, respectively. While for frequencies ω<0.23 (period>27 months), the contemporaneous impact of *short term investments* on *growth* is greater than that of *long term investments*, for ω>0.23, *LTCINF* have the larger effect.

Figure 3 Gain spectrums of capital flows categories



Notes: IPIDEV (deviations of industrial production index from HP-trend) is the output variable. Business cycle frequencies are determined using NBER classification, $0.065 < \omega < 0.35$, which correspond to periodicities between 96 to 18 months.

6. Conclusion

This paper examines the interactions and feedbacks between growth and three categories of private capital flows excluding *FDI*, namely, *portfolio investments*, *short* and *long term ‘other’ investments* (external borrowings of banking and non-banking sectors), in Turkey for the period 1992.1-2009.1 based on monthly BOP data. We make use of frequency domain techniques: in addition to a new version of the causality test of Geweke (1982) and Hosoya (1991) in the frequency domain developed by Breitung and Candelon (2006) we employ other spectral tools such as co-spectrum, coherence squared, phase and gain spectrums. Frequency domain techniques, by decomposing feedbacks between variables of interest over all frequencies $\omega \in (0, \pi)$, provide us a more detailed picture of state compared to time domain methods which give average interactions over all frequencies. In this respect, we believe that our study contains some interesting findings which complete the extant empirical literature on capital flows which primarily focuses on time domain methods.

Some of our empirical findings are as follows. Breakdown of total variance over main frequency bands show that variances of individual flows categories are concentrated over the high seasonal frequencies, especially, over periodicities of 9 to 2 months. That is, the capital flows, even the subcategory which is called "*long term investments*", are mainly short term in nature. The inherent volatility in capital flows stressed by sudden stop literature is true for Turkish case, too.

Secondly, concentrating on business cycle frequencies, our findings from Breitung-Candelon (2006) bivariate causality tests show that, *portfolio investments* (*PORT*) either do not Granger-cause *growth* (*g*) or Granger-cause at only 10% significance level (*IPIDEV*).

Thirdly, there are highly significant feedbacks from *growth* towards *short* and *long term 'other' investments* (*STCINF* and *LTCINF*) although these feedbacks are not robust to growth definition. The percentage of variation in capital flows explained by growth is much higher than the percentage of variation in growth explained by capital flows. All findings support the idea that growth precedes short and long-term capital inflows, both in business cycle and seasonal frequencies. There is no hint to affirm the opposite case, i.e., *flows* precede *growth*. This finding, that is "growth precedes capital flows", can be interpreted as that, in our sample period,1992.1-2009.1, the capital inflows/outflows into/from the country were driven by the internal conditions (dynamics) of Turkey, not by changes in the conditions in international capital markets.

Indeed, the two Turkish financial crises happened in our sample period, 1994 and 2001, are mainly country-specific and huge capital outflows have taken place during these crises (see, Table 1). Furthermore, permanent policy of Turkish governments aiming at holding interest rate differentials (spreads) as high as possible and keeping TL as appreciated as possible, have been main forces behind the attractiveness of Turkey for foreign capital. Hence, as in outflows, inflows also have been driven by internal factors. Of course, sharp changes in international capital markets (e.g., May 2006), economic crises happened in other emerging markets (e.g., 1998 Russian crisis) and new global financial turmoil beginning in mid-2008 causes huge capital outflows from Turkey. Our finding that 'growth precedes capital flows' show that, in our sample period, internal factors overwhelm these external factors.

Overall, our results do not seem to support the view that the main gains from capital inflows are derived in the long run through improvements in quality of institutions and banking supervision, corporate governance and deepening in financial markets, as we did not find any feedback from components of capital inflows to economic growth over business cycle frequencies. Turkey has undergone substantive reforms in financial sector (especially banking) and real sector (privatization) in the last ten years. These reforms have been the main driving force under the lasting economic growth realized in the post-2002 period. Our results suggest that it is the sustainable growth prospects, not the large interest spreads, that attract international investors to the country. Governments should be aware of this fact while making their economic policies. Otherwise, attracting foreign capital only through wide interest spreads will be very costly and unsustainable.

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Appendix

Figure A1
Plot of the data: 1992:01 – 2009:01
(See *Section 4* for definitions)
(Monthly net capital inflows are measured as a fraction of monthly exports)