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State dependence in the finance-growth nexus: a functional coefficient approach

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Abstract
Noting that "one size does not fit all" in the case of the finance-growth (FG) nexus, a growing body of literature has recently focused on uncovering economic conditions under which financial development could be beneficial (detrimental) to economic development. We look into these conditions by means of a flexible semiparametric approach which allows the long-run FG nexus to depend on measurable economic states. Using annual data for 74 economies spanning the period 1975-2005, we find that the level of financial development shows a strong positive impact on the FG nexus. Moreover, although the impact of finance on growth is generally higher in high-income economies, allowing for intra-group variations reveals scenarios where the impact could be higher in low-income economies. However, the FG link could also be negative if low- and lower-middle-income economies have very large governments or are extremely open to international trade.

Keywords: Finance-growth nexus; financial development; economic growth; functional coefficient model.

JEL Classification: C14, C33, O16, G28

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1 Introduction

The importance of services and instruments of the financial system to the real economic sector has been recognized in the literature at least since Schumpeter (1911). However, there are economists who argue that finance does not matter to economic development. According to this view, either the financial system passively responds to the demand arising from the real sector and not vice versa (Robinson, 1952) or there is not at all a meaningful relationship between finance and growth (Lucas, 1988). The intensive research on the finance-growth (FG) nexus in the last two decades has documented mixed results. While there are many studies showing that financial development promotes economic growth (e.g., Christopoulos and Tsionas, 2004; King and Levine, 1993; Levine et al., 2000), there are others which report that it is economic growth which leads to financial development (Ang and McKibbin, 2007). In addition, there are a few studies that diagnose a negligible FG relationship (Andersen and Tarp, 2003).

The inconclusiveness of empirical evidence has recently triggered a growing body of literature that attempts to investigate underlying economic factors which might determine the FG nexus. This has been mostly done either by estimating the FG relationship for different economies grouped according to a certain economic criterion (Rioja and Valev, 2004) or by applying threshold regressions (Ketteni et al., 2007; Yilmazkuday, 2011). So far, the levels of economic and financial development, government size, inflation and openness to trade have been identified to have an impact on the FG nexus (Rioja and Valev, 2004; Rousseau and Wachtel, 2002; Rousseau and Yilmazkuday, 2009; Yilmazkuday, 2011). However, contrasting evidence has emerged with regard to their impact on the FG nexus. For instance, three studies have associated the highest positive FG nexus with three different stages of economic development: low (Huang and Lin, 2009), medium (Yilmazkuday, 2011) and high (Deidda and Fattouh, 2002). Moreover, existing studies have not uncovered conditions which could lead to a negative FG relationship observed by Xu (2000).

We contribute to the empirical literature on the state dependence of the FG nexus in five directions. Firstly, most studies, including Ketteni et al. (2007), Rioja and Valev (2004) and Yilmazkuday (2011), have utilized the same data set that was initially employed by Levine et al. (2000). In this data set, annual time series have been converted to five-year averages to immunize empirical results against the effects of business cycle fluctuations. However, the problems of averaging data have not gone unnoticed in the literature. For example, Ang (2008a) argues that averaging may induce a new type of correlation between time-averaged variables which could markedly differ from the correlation between non-averaged series. Besides, averaging obviously entails a significant (80%) reduction of the sample (Baltagi et al., 2009). In this study, we employ (non-averaged) annual data for 74 economies spanning the period 1975-2005.

Secondly, in the literature thus far, the effects of each factor on the FG nexus have been mostly taken as invariant across stages of economic development or, when considered variant, the association has been made only indirectly. For example, Yilmazkuday (2011) interprets results for economies with small governments to be characteristics for low-income economies by noting that the former have the lowest average income level. Such kind of associations might be problematic especially if the correlation between the considered factor and the income level is low. In this paper, we subdivide economies into four income groups by means of the World Bank's classification criteria to examine the inter- and intra-group variations of the impacts of the considered economic factors on the FG nexus.

Thirdly, except Ketteni et al. (2007), the related literature has imposed a rather strong linear FG relationship below, above or within threshold levels. We relax this assumption by employing a data driven functional coefficient modeling approach. In the spirit of non-parametric kernel estimation, this method attaches more weight to observations close to, and less weight to observations farther away from a local point at which the FG nexus is to be evaluated.

Fourthly, recent studies have shown that financial openness has a significantly positive impact on both economic growth (Bekaert et al., 2011) and financial development (Baltagi et al., 2009). This suggests a positive effect of financial openness on the FG nexus. However, financial openness may replace financial development in terms of key growth-promoting roles, for instance, the provision of risk diversification (Obstfeld, 1994). As a consequence, financial openness might also exert a negative impact on the FG link. In light of conflicting economic reasoning, thus, we empirically assess the net impact of financial openness on the FG link.

Finally, Rousseau and Wachtel (2011) argue that the FG nexus has weakened over time. This 'trend' is supposed to reflect the recent acceleration of financial development that, in turn, has eventually led to financial crises. However, they have employed five-year averaged data. In this paper, we test if their finding is consistent across income groups and is robust to the use of non-averaged annual data by conducting estimations on cross sections split into two subperiods, 1975-1989 and 1990-2005.

To preview some results, the average FG link is found to be positive and increase with the average income level. Yet, there are significant variations within each income group. For instance, increasing financial development appears to strengthen the FG nexus while increasing government size is generally associated with a weakening of the FG link. On the other hand, a negative FG nexus is diagnosed in low-income and lower-middle-income economies where the government size is very large or when they are highly open to international trade. Finally, while the average FG nexus initially increases with the average level of financial openness, economies with the highest level of financial openness stand to benefit the least from financial development. In sum, the FG nexus is found to depend on the levels of economic development, financial development, government size, trade openness and financial openness. Moreover, the impacts of these factors vary across distinct stages of economic development and financial openness.

Section 2 reviews briefly the literature on the state dependence of the FG nexus. Section 3 describes the data and provides parametric estimation results. Section 4 briefly sketches the functional coefficient model and discusses empirical functional estimates. Section 5 concludes. Some technical issues of functional modeling are addressed in Appendix A.

2 Literature review

In this section, we briefly review the theoretical and empirical literature on the state dependence in the FG nexus. Several factors have been suggested in the literature to affect the FG nexus. We discuss each potential determinant in turn.

1. Level of economic development. The debate on the possible dependence of the FG link on the level of economic development can be traced back to Patrick (1966) who conjectures that finance leads to economic growth at earlier stages of economic development while growth induces financial development at later stages. The view that financial development is more beneficial to less developed economies is also shared by Fry (1995) and McKinnon (1973). However, Deidda (2006) and Greenwood and Jovanovic (1990) argue that minimum size requirements or huge startup and maintenance costs necessitate a certain critical level of economic development before financial development may foster economic growth. In view of these conflicting conjectures, it has become quite common to test the FG nexus on distinct samples of high-income and low-income economies. The results are mixed, however. A cross-sectional study by De Gregorio and Guidotti (1995) shows that the FG link is stronger in low-income economies in comparison with high-income economies. These findings are supported by recent evidence from panel data based threshold analysis in Huang and Lin (2009). On the contrary, based on country specific Granger causality tests, Xu (2000) reports a weaker, and for some economies a negative, causality from finance to growth in low-income economies. Similarly, Deidda and Fattouh (2002) and Hassan et al. (2011) have obtained a significantly positive FG nexus for high-income economies and a negligible FG relationship for low-income economies. On the other hand, Yilmazkuday (2011) finds that economies need to have a per capita income of $665 in order to benefit from financial development and the benefits start declining once the income level reaches $1636.

2. Level of financial development. Rioja and Valev (2004) have examined if the level of financial development impacts on the FG nexus. They find that a certain threshold level of financial development is required for a meaningful FG nexus. This is attributed to economies of scale that financial intermediaries could enjoy in agglomerating savings and financing high-return investments. Yet, they have also diagnosed the FG nexus to be smaller in economies with a very high level of financial development than in economies with a medium level of financial development. This is supposed to imply the existence of diminishing marginal returns to improvements in the financial sector. However, Ketteni et al. (2007) have questioned the robustness of the findings in Rioja and Valev (2004) arguing that the likely nonlinear relationship between economic growth and other growth determinants, i.e. initial income and human capital, have been ignored in Rioja and Valev (2004).

3. Level of inflation. A few studies have also shown that finance leads to economic growth only when the level of inflation is low (Huang et al., 2010; Rousseau and Wachtel, 2002; Rousseau and Yilmazkuday, 2009; Yilmazkuday, 2011). This is argued to be a result of the growth-damaging effects of inflation. Inflation is believed to have a negative impact on economic growth because it is usually associated with increased variations in relative prices, which in turn are considered to impact adversely on long-term investments (Temple, 2000; Yilmazkuday, 2011).

4. Government size. A potential determinant of the FG nexus that has not attracted much attention yet is government size. Yilmazkuday (2011) finds that low-income economies benefit from financial development when they have large governments. This indicates that certain types of government expenditures (like on securing property rights, national defence and the legal system) are important for a growth-promoting financial system. Meanwhile, high-income economies are found to achieve a comparably strong FG linkage only if they are characterized by relatively small government sizes. These results are attributed to the possibility that the private sector might be crowded out by the government.

5. Degree of openness to international trade. Yilmazkuday (2011) has also considered trade openness as a possible factor to affect the FG link. He finds that trade openness strengthens the FG link in low-income economies, but its effect is minimal in high-income economies. He argues that increased access to low-cost intermediate inputs, large and high-income markets, and technologies benefits open low-income economies. However, the FG nexus in high-income economies is less affected by trade openness as those economies have their own large domestic markets. Instead, higher financial development coupled with high trade and financial openness might lead to higher vulnerability to international shocks.

6. Degree of financial openness. The impact of financial openness on the FG nexus has not been studied so far. However, there are studies which imply that financial openness could have two opposite effects on the FG nexus. On the one hand, Bekaert et al. (2011) have found a significantly positive impact of financial openness on economic growth. Moreover, Baltagi et al. (2009) have shown that the increasing global trend in financial openness significantly explains the recent surge in the level of financial development. Accordingly, we may expect a positive impact of financial openness on the FG nexus. On the other hand, financial openness could play some of the most important roles of financial development in economic growth, for instance, risk diversification (Obstfeld, 1994). This implies a negative effect of financial openness on the FG nexus. Because of these two contrasting effects, the direction and strength of the impact of financial openness on the FG nexus is not clear at the outset. In this paper, we examine empirically the dependence of the FG nexus on the level of financial openness.

In sum, there appears to be a broad consensus that the FG nexus is state dependent. Levels of economic development, financial development, inflation, government size and openness to trade have been shown to affect the FG nexus. However, the empirical evidence has been largely inconclusive in terms of both the sign and magnitude of the effects of each factor on the FG nexus. In reexamining this issue, we conjecture that applying a more direct way of classifying economies as well as introducing the middle-income categories might solve some of the contradictory results and uncover new important dependencies. We also use functional coefficient modeling that does not impose a linear relationship between finance and growth within estimation windows. Moreover, we introduce financial openness as a new potential determinant of the FG relationship.

3 Data and preliminary analysis

3.1 Data

To investigate state dependence in the FG nexus, we construct panel data sets comprising 74 economies for the period 1975-2005. The economies are selected with regard to data availability of all variables for a sufficiently long time period. As a broad concept involving improvements in the quality and quantity of various financial intermediary services measuring financial development is always difficult. We use the arguably most common measure, namely, credit by deposit money banks and other financial institutions to the non-financial private sector as a percentage of GDP (PRV). It excludes credit to public institutions

Table 1: Summary statistics, 1975-2005

Variable	Mean	Max	Min	Std	CV	Mean	Max	Min	Std	CV
	World, 74 economies									
GDPPC	7469.0	40617.8	107.0	8939.3	1.20					
PRV	44.4	200.6	1.4	37.2	0.84					
GOV	16.5	54.5	3.2	6.3	0.38					
OPEN	71.9	220.4	6.3	36.7	0.51					
FOPEN	0.1	2.5	-1.8	1.5	18.97					
INF	11.6	439.0	-23.5	22.6	1.94					
	Low-income economies, 19					*Low-FOPEN economies, 19 (10,5,2,2)*				
GDPPC	357.2	1106.7	107.0	185.4	0.52	2492.7	18136.4	107.0	4060.2	1.63
PRV	16.3	41.2	1.4	8.8	0.54	30.2	160.9	1.4	30.6	1.01
GOV	14.7	54.5	5.9	6.7	0.46	14.4	38.8	3.2	5.8	0.40
OPEN	59.6	187.7	6.3	33.7	0.57	67.3	194.8	6.3	39.8	0.59
FOPEN	-0.8	2.5	-1.8	0.8	-0.94	-1.1	1.7	-1.8	0.5	-0.46
INF	12.0	165.7	-12.3	16.3	1.36	14.6	439.0	-12.3	27.5	1.88
	Lower-middle-income economies, 16					*Lower-middle-FOPEN economies, 18 (8,6,3,1)*				
GDPPC	1542.1	3561.3	368.7	655.9	0.43	1654.2	13801.8	149.7	2089.8	1.26
PRV	31.4	166.0	3.6	25.3	0.81	26.3	144.6	3.5	20.9	0.79
GOV	13.8	38.8	3.2	6.0	0.44	15.0	43.0	5.7	5.9	0.40
OPEN	73.0	209.4	24.9	32.5	0.45	77.5	209.4	26.6	35.3	0.46
FOPEN	-0.6	2.5	-1.8	1.1	-1.88	-0.5	2.5	-1.8	0.9	-1.59
INF	12.6	439.0	-23.5	26.0	2.06	10.8	334.6	-20.8	20.1	1.86
	Upper-middle-income economies, 14					*Upper-middle-FOPEN economies, 18 (1,5,5,7)*				
GDPPC	4801.0	16429.0	830.8	2578.7	0.54	8095.8	40617.8	306.6	8683.7	1.07
PRV	37.1	155.3	3.7	26.9	0.73	44.3	197.4	6.5	30.4	0.69
GOV	16.7	38.8	5.0	6.4	0.38	16.1	54.5	5.0	6.8	0.43
OPEN	94.4	220.4	16.5	43.4	0.46	69.3	148.3	16.5	27.1	0.39
FOPEN	0.3	2.5	-1.8	1.5	4.70	0.2	2.5	-1.8	1.4	6.04
INF	15.8	334.6	-20.8	27.9	1.77	14.5	390.7	-23.5	26.4	1.83
	High-income economies, 25					*High-FOPEN economies, 19 (0,0,4,15)*				
GDPPC	18161.4	40617.8	2595.1	7297.2	0.40	17360.4	38971.8	1430.6	8018.7	0.46
PRV	78.3	200.6	19.3	36.7	0.47	75.9	200.6	3.7	40.9	0.54
GOV	19.5	43.4	10.4	4.8	0.25	20.4	38.8	9.8	4.8	0.24
OPEN	67.9	184.7	16.0	31.2	0.46	73.4	220.4	16.0	41.5	0.57
FOPEN	1.1	2.5	-1.8	1.4	1.37	1.7	2.5	-1.8	1.0	0.57
INF	8.4	390.7	-1.8	20.6	2.44	6.8	106.8	-18.6	12.3	1.81

Note: Full definitions of the variables and data sources are given in the text. Except GDPPC and FOPEN, all variables are measured as percentage values. Max, min, std and cv represent minimum, maximum, standard deviation and coefficient of variation, respectively. Entries next to the number of economies in each financial openness category denote, respectively, the number of low-income, lower-middle-income, upper-middle-income and high-income economies that belong to the corresponding financial openness category.

and credit issued by the central bank. As a result, it measures the activity of financial intermediaries in channeling savings to investors. Consequently, it is argued to be more closely associated with the impact of financial development on investment and economic growth than other measures like the percentage of monetary aggregates M2 or M3 in GDP (De Gregorio and Guidotti, 1995; Levine et al., 2000). Following standard practice in the FG nexus literature (e.g., Apergis et al., 2007; Christopoulos and Tsionas, 2004; Demetriades and Hussein, 1996), economic development is measured by means of real GDP per capita (GDPPC). Government size is approximated in terms of government consumption expenditure as a percentage of GDP (GOV). Due to several missing values in the data for inflation implied by the Consumer Price Index, we instead use the growth rate of the GDP deflator (INF). Trade openness is measured as the percentage of imports plus exports in GDP (OPEN). We employ the financial openness measure (FOPEN) suggested in Chinn and Ito (2008). FOPEN is derived as the first principal component of the reverse of four dummy variables that indicate major restrictions on cross-border capital transactions as reported in the Annual Report on Exchange Arrangements and Exchange Restrictions of the IMF.

PRV is obtained from the 2008 update of the financial structure data base of Beck et al. (2000)[1] while FOPEN is taken from Menzie Chinn's website.[2] The remaining time series are drawn from the 2009 edition of the World Development Indicators of the World Bank.

To get deeper insights into each factor's effects on the FG link across stages of economic development, we categorize the 74 economies into four by their latest (2005) income level according to the World Bank's contemporary classification criteria.[3] In particular, economies whose latest real per capita GDP (in constant 2000 US Dollar) fall in the ranges <876, 876-3465, 3466-10725, > 10725 are classified as low-income (19 economies), lower-middle-income (16), upper-middle-income (14) and high-income (25), respectively.[4] The list of economies included in each sample is provided in Appendix B. The low-income category includes 15 Sub-Saharan African (SSA) economies plus India, Nepal, Pakistan and Papua New Guinea while the high-income group adds Bahamas and Cyprus to 23 OECD economies. The remaining 14 Latin American economies considered in this study are equally divided into lower- and upper-middle-income economies.

As an alternative means of classifying sample information, we categorize economies into four groups with respect to their average level of FOPEN. Additionally, we subdivide each cross section into two subperiods, 1975-1989 and 1990-2005, to test recent findings by Rousseau and Wachtel (2011) that the FG nexus is weakening over time.

Table 1 shows some descriptive statistics of the data covering the full-sample period. It provides the means, minimum and maximum values and standard deviations for the different cross sections. It can be seen that the data set is characterized by considerable

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[1] http://go.worldbank.org/X23UD9QUX0

[2] http://www.ssc.wisc.edu/~mchinn/research.html

[3] http://data.worldbank.org/about/country-classifications/a-short-history.

[4] As in the standard growth literature, we measure economic development by means of GDP per capita. Accordingly, to see the state dependence of the FG nexus across stages of economic development, we classify economies based on their GDP per capita. However, the World Bank classifies economies based on their per capita Gross National Income (GNI). Moreover, noting that economy specific quotes of GNI per capita and GDP per capita may differ markedly, there are five economies which we group differently than the World Bank. These are Algeria, Cameroon, Malta, Saudi Arabia, and Trinidad and Tobago.

variations within/between cross sections. The mean of the financial development measure PRV increases with the stage of economic development. However, across stages of financial openness, both average PRV and average per capita income (GDPPC) initially decrease and later increase with financial openness, indicating positive but nonlinear PRV-FOPEN and GDPPC-FOPEN relationships. The table also documents how economies in a certain category of financial openness are distributed over the income groups. In particular, low-income economies predominate in low and lower-middle financial openness categories while high-income economies take the largest shares in upper-middle and high financial openness categories.

3.2 Parametric regression results

Before moving to the functional coefficient modeling in the next section, we first look at parametric estimations of the FG nexus across distinct income groups and categories of financial openness. This allows comparability with related studies. Moreover, as the economies are classified with regard to their income level (financial openness), differences in the parametric FG nexus estimates could also hint at the impact of economic development (financial openness) on the FG nexus. For this purpose, we employ a standard panel dynamic OLS (DOLS) approach where GDP per capita is regressed on financial development and a few control variables (Ang, 2008b; Apergis et al., 2007; Christopoulos and Tsionas, 2004). In DOLS estimation, the explanatory variables in levels are augmented with the lags and leads of their first differences to account for potential endogeneity and serial correlation (Saikkonen, 1991; Stock and Watson, 1993). Formally, the model reads as

$$\begin{aligned} GDPPC_{it} = \mu_i + \beta_1 PRV_{it} + \beta_2 GOV_{it} + \beta_3 OPEN_{it} + \beta_4 INF_{it} + \sum_{j=-1}^{1} c_{1j} \Delta PRV_{it+j} \\ + \sum_{j=-1}^{1} c_{2j} \Delta GOV_{it+j} + \sum_{j=-1}^{1} c_{3j} \Delta OPEN_{it+j} + \sum_{j=-1}^{1} c_{4j} \Delta INF_{it+j} + u_{it}, \\ t = 1, ..., T, \quad i = 1, ..., N. \end{aligned} \tag{1}$$

where $GDPPC_{it}$, PRV_{it}, GOV_{it}, $OPEN_{it}$, and INF_{it} represent GDP per capita, financial development, government size, openness to trade, and inflation, respectively, in time t and economy i. Moreover, Δ is short for the first difference operator, e.g. $\Delta PRV_{it} = PRV_{it} - PRV_{it-1}$, μ_i are fixed effects and $u_{it} \sim (0, \sigma_u^2)$. [5] Equation (1) can be written compactly as

$$y_{it} = \boldsymbol{x}_{it}'\boldsymbol{\beta} + \boldsymbol{z}_{it}'\boldsymbol{\gamma} + u_{it}, \tag{2}$$

where $y_{it} = GDPPC_{it}$, $\boldsymbol{x}_{it} = (PRV_{it}, GOV_{it}, OPEN_{it}, INF_{it})'$, and $\boldsymbol{z}_{it}$ collects the fixed effects and lags and leads of first differences of the explanatory variables. Accordingly, $\boldsymbol{\beta} = (\beta_1, \beta_2, \beta_3, \beta_4)'$ while $\boldsymbol{\gamma}$ contains the parameters attached to the fixed effects and short-run dynamics. To allow for heterogeneous short-run coefficients, we partial out $\boldsymbol{z}_{it}$ from (2). To this end, we denote matrices collecting observations in $y_{it}, \boldsymbol{x}_{it}$ and $\boldsymbol{z}_{it}$ for economy i by

[5] Estimation results are qualitatively unaffected by consideration of higher lag and lead orders.

$Y_i, \boldsymbol{X}_i$ and $\boldsymbol{Z}_i$, respectively, and henceforth consider the partial system

$$\tilde{y}_{it} = \tilde{\boldsymbol{x}}'_{it}\boldsymbol{\beta} + \tilde{u}_{it} \tag{3}$$

where $\tilde{y}_{it}$, $\tilde{\boldsymbol{x}}_{it}$ and $\tilde{u}_{it}$ are typical elements of, respectively, $\tilde{Y}_i = \boldsymbol{M}_i Y_i$, $\tilde{\boldsymbol{X}}_i = \boldsymbol{M}_i \boldsymbol{X}_i$ and $\tilde{u}_i = \boldsymbol{M}_i u_i$; $\boldsymbol{M}_i = I_i - \boldsymbol{Z}_i(\boldsymbol{Z}'_i\boldsymbol{Z}_i)^{-1}\boldsymbol{Z}'_i$; and I_i denotes the $(T \times T)$ identity matrix.

The left and right hand sides of Table 2 document estimation results using data from the four categories of income and financial openness, respectively. Moreover, full sample results (74 economies) are shown. Results on the full-period samples demonstrate a statistically and economically significant, positive, long-run impact of financial development on economic growth in all the cross sections. This positive impact is in line with much of the empirical FG literature (see Levine, 2005, for a broad survey). Furthermore, the estimated coefficients are the larger the higher is the income level of the subsamples. In particular, the FG coefficient estimate for high-income economies is three times larger than that for low-income economies. This underpins the dependence of the FG nexus on the income level.

The right hand part of Table 2 indicates that economies with the highest level of financial openness benefit the least from financial development. Moreover, the weakest FG link in those economies is observed in the recent period. This negative impact of very high financial openness on the FG nexus could be explained by noting that both financial development and financial openness might serve the same beneficial roles to economic development. For example, providing risk diversification and hence increasing the probability of investment in high-risk, high expected-return projects is generally considered as an important function ascribed to both financial development (Greenwood and Jovanovic, 1990; Levine, 2005) and financial openness (Bekaert et al., 2011; Obstfeld, 1994).

On the other hand, breaking the samples into two periods (Panels 2 and 3 of Table 2) reveals that, in contrast to the findings in Rousseau and Wachtel (2011), most of the cross sections are characterized by a stronger FG nexus in the recent period. It is only in high-income and in high-financial openness economies that we find a weakened FG link. The result in high-income economies might be explained by noting that the financial development occurring outside the banking sector, which is not be captured by PRV, makes up a large and growing share of the overall financial development in those economies.

Table 2 also documents some model diagnostics with respect to the presence of serial correlation and unit roots in the residuals as well as poolability tests. In most cross sections, we obtain satisfactory results for all the three diagnostic tests. Specifically, in all cross sections, the null hypothesis of a panel unit root using the diagnostics of Levin et al. (2002) and Breitung (2000) is rejected. Thus, at the panel level the performed DOLS regression does not suffer from spurious dependence. Poolability test results also indicate that the pooled regression estimates are not systematically different from mean group estimates for most cross sections. Thus, after allowing for fixed effects and cross-section-specific transitory dynamics, pooling is not overly restrictive to uncover the long-run determinants of per capita income. Mitigating this overall evidence slightly, however, results from high-financial openness economies show a failure to satisfy the poolability restrictions in both the full-period and sub-period regressions. Therefore, a fair degree of caution should be given in interpreting the corresponding FG estimates. Finally, the null hypothesis of no

Table 2: Parametric regression results

Variables	Cross sections *Low income*	*Lower-middle*	*Upper-middle*	*High income*	*Low FOPEN*	*Lower-middle*	*Upper-middle*	*High FOPEN*	*World74*
Panel 1: 1975-2005									
PRV	0.118	0.142	0.268	0.345	0.219	0.215	0.246	0.114	0.226
	(.016)*	(.021)*	(.031)*	(.016)*	(.019)*	(.023)*	(.024)*	(.015)*	(.010)*
GOV	0.033	-0.304	-0.099	-0.017	-0.157	-0.039	-0.004	-0.460	-0.120
	(.024)	(.039)*	(.089)	(.070)	(.039)*	(.042)	(.041)	(.068)*	(.021)*
OPEN	0.168	0.268	0.242	0.378	0.135	0.057	0.264	0.715	0.215
	(.026)*	(.029)*	(.062)*	(.042)*	(.029)*	(.043)	(.040)*	(.038)*	(.018)*
INF	0.211	0.026	0.003	-0.173	0.096	-0.568	-0.099	-0.526	-0.067
	(.055)*	(.057)	(.103)	(.031)*	(.050)	(.162)*	(.035)*	(.071)*	(.026)*
Serial corr.	10.526	12.500	28.571	8.000	15.789	5.556	22.222	10.526	13.514
Poolability	8.584	3.487	2.968	7.948	3.691	1.246	8.108	11.627*	6.570
LLC	-7.364*	-6.363*	-6.639*	-8.919*	-7.476*	-6.719*	-8.745*	-7.711*	-14.671*
Breitung	-4.584*	-3.921*	-4.161*	-4.614*	-4.397*	-4.188*	-4.650*	-4.500*	-6.042*
Panel 2: 1975-1989									
PRV	0.065	0.087	0.093	0.380	0.110	0.189	0.118	0.166	0.155
	(.027)*	(.024)*	(.054)	(.024)*	(.028)*	(.036)*	(.041)*	(.025)*	(.016)*
GOV	0.128	-0.312	-0.165	-0.073	-0.055	-0.020	0.008	-0.611	-0.092
	(.038)*	(.048)*	(.118)	(.100)	(.059)	(.061)	(.066)	(.106)*	(.032)*
OPEN	0.219	0.131	0.272	0.246	0.207	0.038	0.273	0.455	0.213
	(.039)*	(.034)*	(.113)*	(.064)*	(.039)*	(.061)	(.065)*	(.069)*	(.026)*
INF	0.141	0.059	-0.062	-0.022	0.091	-0.018	-0.011	-0.304	0.018
	(.068)*	(.082)	(.155)	(.033)	(.071)	(.199)	(.044)	(.133)*	(.034)
Serial corr.	21.053	25.000	14.286	12.000	36.842	5.556	11.111	15.789	17.568
Poolability	7.073	3.159	1.769	11.283*	4.593	1.432	4.229	17.882*	9.597*
LLC	-7.085*	-6.448*	-7.336*	-7.793*	-8.969*	-5.490*	-7.002*	-7.784*	-14.012*
Breitung	-3.795*	-3.704*	-3.795*	-3.282*	-4.609*	-3.098*	-2.992*	-3.427*	-4.436*
Panel 3: 1990-2005									
PRV	0.120	0.152	0.283	0.307	0.241	0.204	0.259	0.061	0.224
	(.022)*	(.022)*	(.041)*	(.022)*	(.027)	(.027)*	(.030)*	(.022)*	(.014)*
GOV	-0.029	-0.124	0.078	-0.008	-0.136	-0.100	0.070	-0.327	-0.090
	(.035)	(.044)*	(.124)	(.092)	(.051)	(.052)	(.064)	(.093)*	(.029)*
OPEN	0.135	0.267	0.175	0.413	0.079	0.104	0.216	0.692	0.196
	(.035)*	(.039)*	(.097)	(.054)*	(.045)	(.054)	(.056)*	(.052)*	(.026)*
INF	0.234	0.034	-0.131	-0.243	0.077	-0.782	-0.077	-0.409	-0.036
	(.064)*	(.045)	(.137)	(.062)*	(.054)	(.173)*	(.068)	(.079)*	(.036)
Serial corr.	31.579	18.750	7.143	12.000	21.053	22.222	22.222	5.263	17.567
Poolability	9.044	5.875	5.461	5.491	3.245	3.930	12.456*	13.079*	7.490
LLC	-7.857*	-8.175*	-5.454*	-7.935*	-7.881*	-7.224*	-7.658*	-5.055*	-14.513*
Breitung	-4.660*	-4.378*	-3.449*	-3.547*	-4.543*	-3.826*	-3.690*	-2.595*	-5.085*

Notes: The dependent variable is GDPPC. The model includes a constant and contemporaneous as well as one lag and lead of the first differences of the explanatory variables. Apart from INF, all variables are used in logarithmic forms. The values provided in parentheses are estimated standard errors. Rejections of the null hypothesis at the 5% level of significance are indicated by *. Reported numbers of the serial correlation tests of Breusch (1978) and Godfrey (1978) represent percentages of economy specific regressions where tests indicate rejections of the null hypothesis of no first order serial correlation with 5% significance. Entries corresponding to LLC and Breitung are obtained by applying homogeneous panel unit root tests of Levin et al. (2002) and Breitung (2000), respectively, on the pooled residuals. The null hypothesis of the employed poolability test is that reported long-run parameter estimates are not systematically different from mean group estimates.

first order serial correlation is rejected for about 13% of the economies, a large proportion of which are upper-middle-income economies. Although the empirical rejection frequency exceeds the nominal significance level of the diagnostic tests to some extent, we refrain from model respecification for two reasons. First, serial correlation diagnostics improve if we use more than one lag of the first differences in the DOLS regression while higher order transitory dynamics leaves the evaluation of the FG link qualitatively unaffected. Second, eventual residual correlation does not invalidate consistency of the long-run DOLS parameter estimates.

4 Functional coefficient modeling

In this section, we first briefly outline the functional coefficient model that allows the long-run parameters in (1) to depend on potential economic states and then discuss empirical results. Issues of estimation and inference within the functional coefficient model are deferred to Appendix A.

4.1 The semiparametric model

We denote a factor or state variable, for instance, the degree of trade openness, by ω. The full list of factors that we actually employ is provided below. As we are interested in the state dependence of the long-run parameters, we presume that all the short-run parameters and the deterministic terms are factor invariant. Thus, we generalize (3) towards a functional representation. The functional model reads as

$$\tilde{y}_{it} = \tilde{\boldsymbol{x}}_{it}'\boldsymbol{\beta}(\omega) + \tilde{u}_{it}, \quad \omega_{it} = \{\sigma_t(\tilde{\omega})\}^{-1}(\tilde{\omega}_{it} - \bar{\omega}_t), \tag{4}$$

where $\bar{\omega}_t = N^{-1}\sum_{i=1}^{N}\tilde{\omega}_{it}$ and $\sigma_t(\tilde{\omega})$ are the time-specific cross-sectional mean and standard deviation of the factor observations $\tilde{\omega}_{it}$, respectively. Equation (4) allows the relation between economic development and its long-run determinants to depend on the measurable economic factor $\tilde{\omega}_{it}$.

As outlined in Appendix A, kernel-based estimates of the semiparametric model can be interpreted as weighted pooled regression estimates, where the weights attached to particular observations $\{\tilde{y}_{it}, \widetilde{\boldsymbol{x}}_{it}\}$ depend on the time local position of the factor in the cross section of time series. As we are interested only in the functional dependence of the FG nexus, our discussion is, henceforth, restricted to $\hat{\beta}_1(\omega)$. Functional estimates $\hat{\beta}_1(\omega)$ can be displayed graphically. Noting that we have standardized the factor, the following grid is used:

$$\hat{\beta}_1(\omega), \omega = -2 + 0.1\kappa, \kappa = 0, 1, 2, ..., 40. \tag{5}$$

Thus, estimates $\hat{\beta}_1(\omega)$ reflect the effect of attaching relatively high kernel weights to economies which are above ($\omega > 0$), close to ($\omega = 0$) or below ($\omega < 0$) the factor's average time path.

4.2 Functional coefficient estimates

In this section, we discuss results obtained from the functional coefficient model in (4)[6]. Potential factor variables are mainly selected in light of the related literature (Rioja and Valev, 2004; Yilmazkuday, 2011). They include the level of the government size (GOV), financial development (PRV), openness to international trade (OPEN), and inflation (INF). As it is generated from four dummy variables, the financial openness measure, FOPEN, has poor scale properties. Therefore, we do not employ it as a factor in the functional coefficient modeling. Instead, we examine its impact on the state dependence of the FG nexus by considering cross sections of distinct degrees of financial openness.

To test if the FG nexus is dependent on a particular factor, we apply the factor based bootstrap approach proposed in Herwartz and Xu (2009). A brief discussion of the tests is provided in Appendix A. We first look at the global factor-invariance test results and then discuss the factor-dependent FG nexus with respect to local parametric estimation. The conventional 5% significance level is used to decide if a given factor has a statistically significant impact on the FG nexus.

Table 3: Global factor invariance test results

		Income groups					FOPEN categories				
Factor	period	low	lower-middle	upper-middle	high	world74	1st	2nd	3rd	4th	pooled
GOV	1975-2005	.000	.015	.000	.024	.003	.000	.000	.015	.065	.005
	1975-1989	.000	.180	.015	.195	.182					
	1990-2005	.000	.035	.074	.004	.040					
PRV	1975-2005	.000	.000	.149	.000	.000	.000	.000	.000	.000	.000
	1975-1989	.012	.015	.099	.172	.000					
	1990-2005	.000	.000	.011	.001	.000					
OPEN	1975-2005	.000	.000	.014	.000	.001	.042	.432	.016	.000	.014
	1975-1989	.003	.019	.053	.304	.011					
	1990-2005	.001	.000	.003	.004	.083					
INF	1975-2005	.355	.654	.241	.829	.010	.362	.353	.133	.253	.013
	1975-1989	.891	.920	.850	.408	.545					
	1990-2005	.143	.567	.106	.895	.005					

Notes: Apart from INF, all variables are used in logarithmic forms. Reported numbers are (bootstrap) p-values. The number of bootstrap replications is 1000. The columns corresponding to "FOPEN categories" refer to p-values obtained by applying the test on the four quartiles of the pooled data sorted with respect to the level of FOPEN.

The global factor-invariance test results documented in Table 3 show that the null hypothesis of a constant FG nexus can be rejected if we use government size, financial development or trade openness as a state variable. One exception is when financial development is employed as a factor in upper-middle-income economies. As it turns out, inflation fails to be a significant determinant of the FG link in all the cross sections except the most comprehensive sample. Consequently, we will not take inflation as a factor in the ensuing discussions.

[6] All computations are done in MATLAB 2011a.

4.2.1 Government size

Figure 1 depicts the estimated functional FG nexus obtained by employing government size as a factor variable. The displayed functional estimates show that in low-income and high-income economies the FG link weakens with increasing government size. More importantly, we obtain a negative FG nexus in low-and lower-middle-income economies with large government sizes. This result supports the conjecture raised by Xu (2000) that a high degree of government regulation could be the reason for the negative FG nexus in low income economies. In upper-middle-income economies, a medium government size appears to be favorable for a higher FG relationship while economies with very small or very large governments tend to lose the growth promoting effects of financial development. This is in accordance with findings in Yilmazkuday (2011). These results likely underscore the importance of certain types of government expenditure like on securing property rights, national defense and the legal system that facilitate the efficient functioning of the financial sector. Yet, the fact that the FG nexus becomes low when the size of the government is large hints at the prevalence of excessive government regulations in such economies. In high-income (OECD) economies, governments are relatively larger (see Table 1) and strong legal systems that enforce property rights and financial contracts are already in place. As a result, additional government consumption mainly crowds out the private sector. This leads to a lesser efficiency in the utilization of the funds channeled to the private sector (PRV), and hence a decline in the FG link. In line with this reasoning, functional estimates in the fourth column of Figure 1 show that in high-income economies small governments are associated with a very strong FG link and increasing government size weakens the FG nexus.

Additionally, the second and the third rows of Figure 1 illustrate that the functional dependence of the FG nexus on the government size remains largely similar in the two subperiods. If any, large government sizes in upper-middle-income economies are associated with a negative FG nexus in the first period, casting additional doubt on the benefit of having large governments even in those economies. Furthermore, a negative relationship between government size and the FG nexus is obtained in all categories of financial openness. This strengthens the general implications from the above discussion that large government sizes adversely affect the FG nexus.

4.2.2 Financial development

Figure 2 displays the estimated functional dependence of the FG nexus with respect to the level of financial development. It can be seen that low-income economies with high level of financial development show a relatively high FG nexus. In general, there is an increasing FG nexus for additional degrees of financial development, most likely because the scale of the growth-promoting functions of the financial sector (Levine, 2005) increases as the financial system develops. For example, the financial sector has to reach a certain threshold of development before it could agglomerate savings that are high enough to finance indivisible, high return, investments (Rioja and Valev, 2004). The risk diversification and high-return project identification (Rioja and Valev, 2004) functions also require a relatively high level of financial development.

Splitting full-period cross sections into two obtains that most of the functional relations

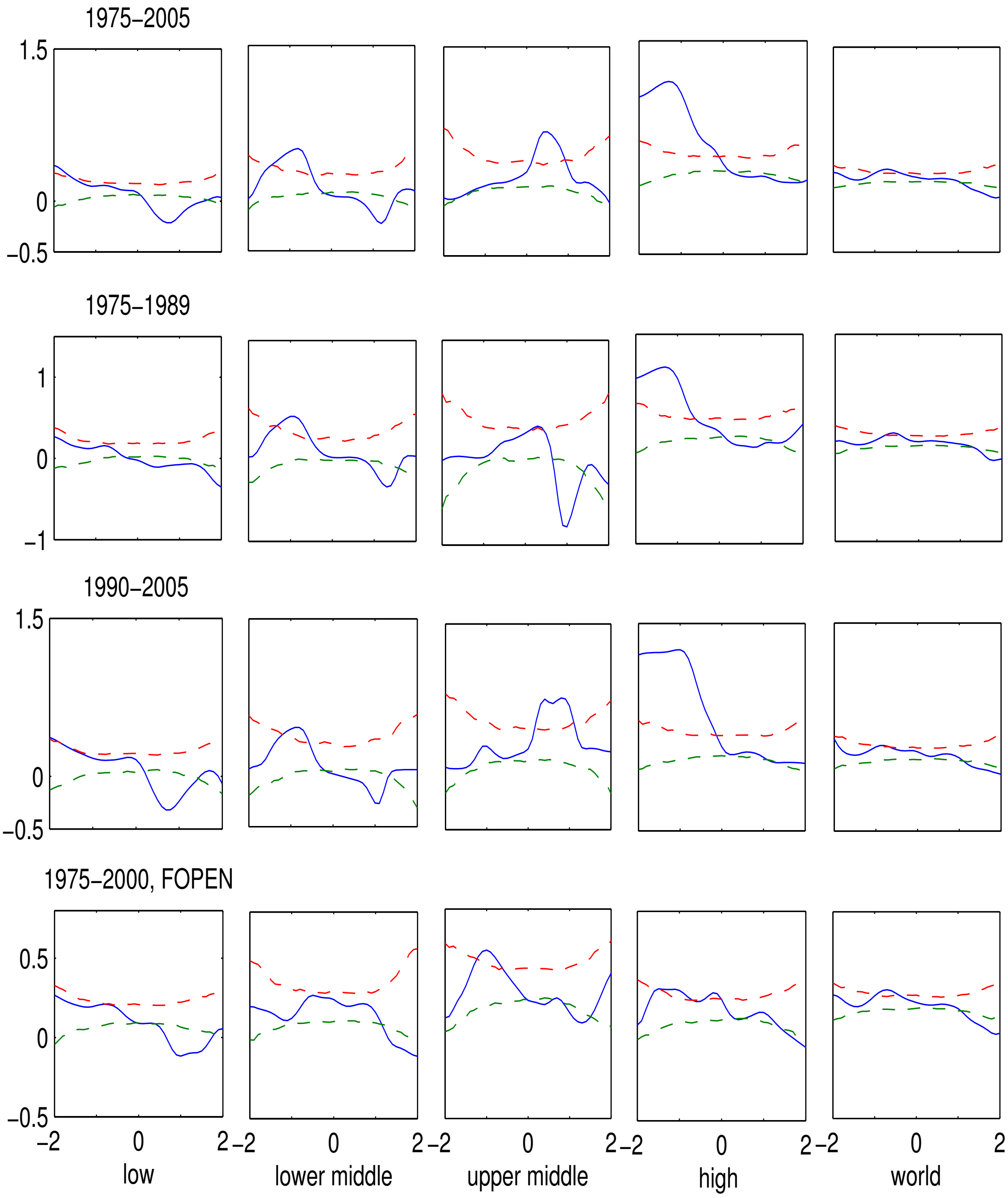

Figure 1: Functional coefficient model estimates of the FG nexus conditional on the level of government size (GOV). The figures show estimated long-run effects $\hat{\beta}_1(\omega)$, with $\hat{\beta}_1$ on the vertical and ω on the horizontal axes. The solid line shows the point estimates and the two dashed lines are the 95% confidence intervals of the model excluding functional dependence.

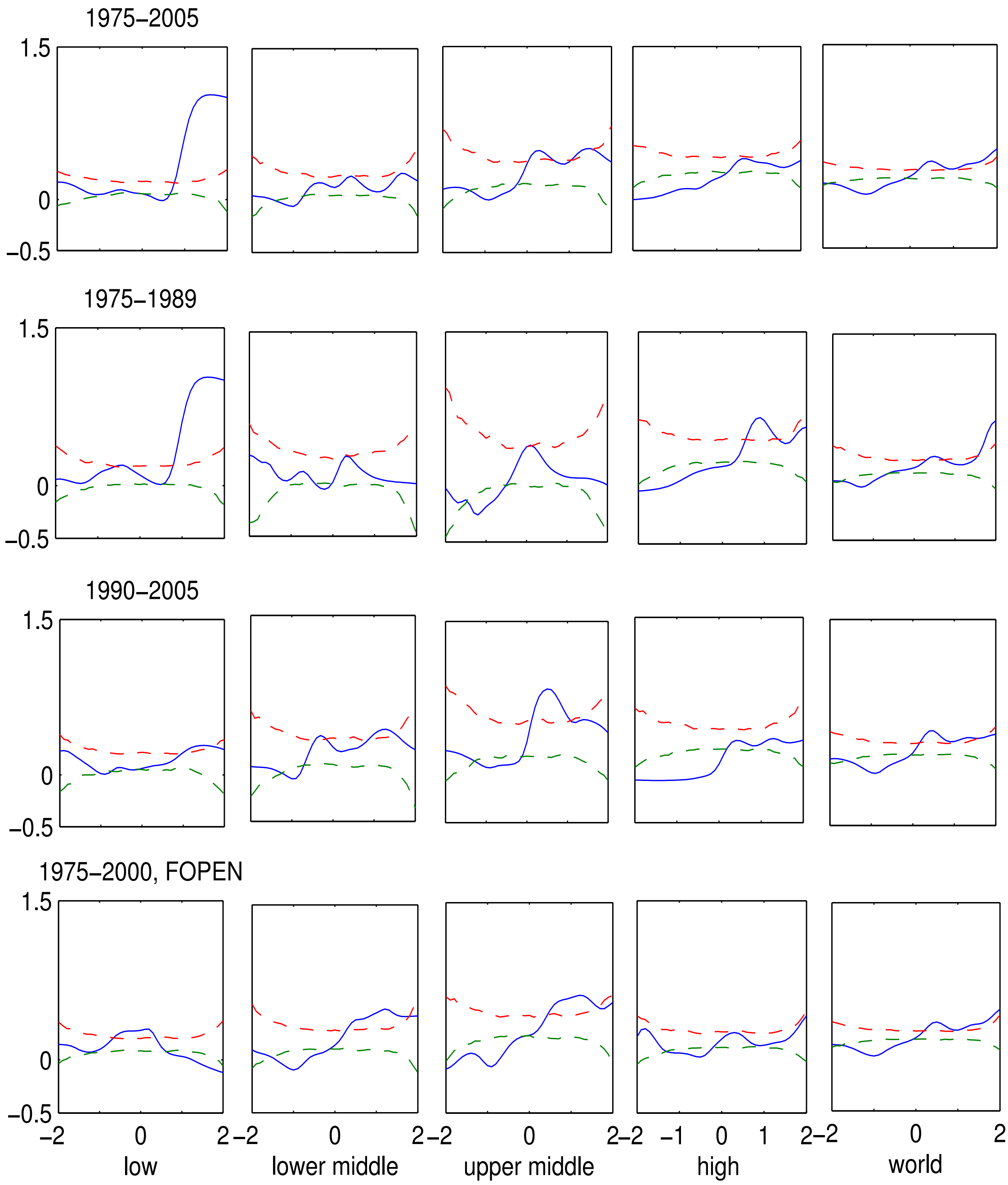

Figure 2: Functional coefficient model estimates of the FG nexus conditional on the level financial development (PRV). The figures show estimated long-run effects $\hat{\beta}_1(\omega)$, with $\hat{\beta}_1$ on the vertical and ω on the horizontal axes. The solid line shows the point estimates and the two dashed lines are the 95% confidence intervals of the model excluding functional dependence.

discussed above prevail in both subperiods. However, the higher FG nexus in low income economies with very high level of financial development is not diagnosed in the second subperiod. Results documented in the fourth row of Figure 2 illustrate that the effect of financial development on the FG nexus depends on the level of financial openness. A moderate level of financial openness is associated with a beneficial role of financial development on the FG nexus. However, the average FG link is apparently the weakest in states of higher financial openness. These findings highlight that the similar growth-promoting roles of financial openness and financial development (Obstfeld, 1994) are likely complementary for moderate levels of both trigger variables.

4.2.3 Openness to trade

Trade openness can result in two opposite effects on the overall macroeconomic performance of an economy. On the one hand, it may lead to enhanced efficiency by providing access to new raw materials and products, low-cost intermediate goods, larger markets and latest technologies (Yanikkaya, 2003). On the other hand, it could also induce macroeconomic instability (Rodrik, 1992) and increase vulnerabilities to international shocks (Yilmazkuday, 2011). Trade openness may also impact on financial development. Rajan and Zingales (2003) argue that trade openness, if coupled with financial openness, can weaken the industrial and financial incumbents' resistance and promote financial development.[7] In testing this claim, Baltagi et al. (2009) find that trade openness induces financial development even in financially closed economies. As a result, the possible effect of trade openness on the FG nexus is not clear at the outset.

The results depicted in Figure 3 indicate that the impact of trade openness on the FG nexus varies across stages of economic development. In low- and lower-middle-income economies, a moderate level of trade openness stimulates the FG nexus, but extreme openness could lead to a negative FG relationship. Except the negative FG link, the hump-shaped relationship between trade openness and the FG nexus corroborates the results reported in Yilmazkuday (2011). The negative FG nexus might highlight the failure of domestic firms in extremely open low-and lower-middle-income economies to withstand foreign competition. In contrast, upper-middle-income economies show a marked FG nexus when they are highly open to trade. This might be because of the better utilization of credits by firms in those economies when they are given access to a broader international market and/or when they face strong competition of foreign firms. However, we do not observe any clear pattern for the impact of openness on the FG nexus in high-income economies. For most income groups, subperiod estimation results are qualitatively similar to the full-period estimates. However, the FG link in upper-middle-income economies that are less open to international trade turned out to be negative in the recent period. This might imply that, in a period when most upper-middle-income economies have become increasingly open to international trade, those economies with a lower level of trade openness are most likely poor performing ones.

The effects of trade openness on the FG nexus also differ across categories of financial openness. When financial openness is low, moderate trade openness increases the FG nexus

[7] Rajan and Zingales (2003) argue that incumbents in the industrial and financial sector are opposed to financial development because it generates competition and erodes their rents.

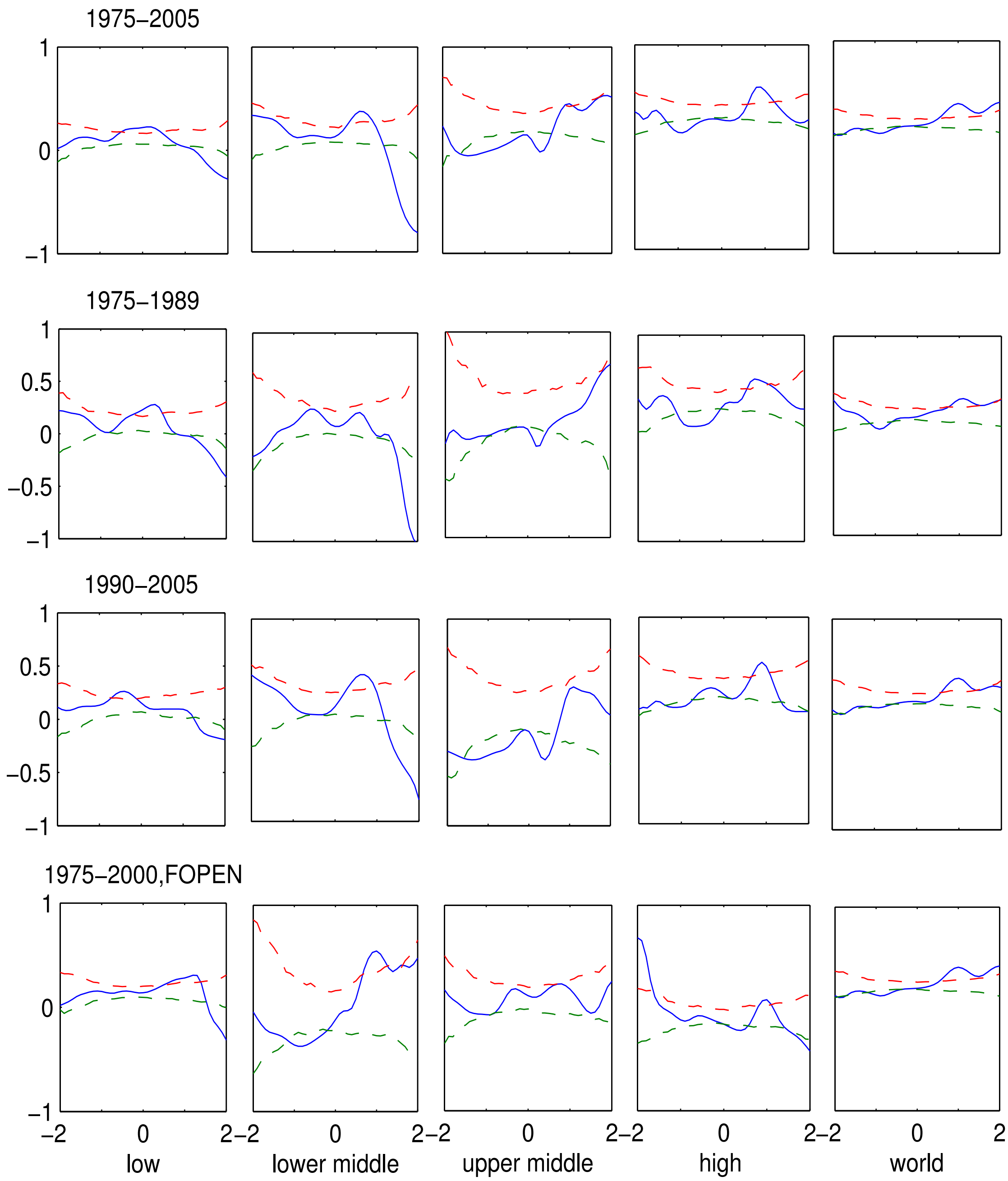

Figure 3: Functional coefficient model estimates of the FG nexus conditional on the levels of trade openness (OPEN). The figures show estimated long-run effects $\hat{\beta}_1(\omega)$, with $\hat{\beta}_1$ on the vertical and ω on the horizontal axes. The solid line shows the point estimates and the two dashed lines are the 95% confidence intervals of the model excluding functional dependence.

while a very high level of trade openness induces a declining FG link. When financial openness is high, however, the negative relationship between trade openness and the FG nexus begins with the minimum level of trade openness under consideration. This result supports our conclusion from the parametric estimations that both financial openness and financial development play similar roles in economic development. More importantly, the fact that the FG nexus could even be negative if trade openness is also very high underscores the increased vulnerability to international shocks in such states.

5 Conclusions

We investigate the state dependence in the FG nexus by means of semiparametric functional coefficient models on a data set comprising 74 economies over the period 1975-2005. We find that the FG link is dependent on an economy's level of economic and financial development, government size, trade openness and financial openness, but not on the level of inflation. Moreover, the effects of the economic factors on the FG link are diagnosed to be variant across the distinct stages of economic development.

We find a generally positive effect of income level on the FG link. In particular, low-income economies obtain the least benefit from financial development while high-income economies enjoy three times as much benefit. Similarly, financial development has a generally positive effect on the FG nexus, with the strongest FG link observed in low-income economies with a high level financial development. There are also cases where financial development could have an adverse effect on economic growth. This is observed in low- and lower-middle-income economies when they have very large governments or are extremely open to international trade. The impact of openness to trade varies even between lower-middle- and upper-middle-income economies. Upper-middle-income economies show a pronounced FG nexus when they are highly open to international trade. Yet, only a moderate level of trade openness is beneficial to lower-middle-income economies and being extremely open is found to induce a negative FG relationship. Finally, while increasing financial openness to some extent strengthens the FG nexus, economies with the highest level of financial openness are found to benefit the least from financial development. Furthermore, the FG nexus could even be negative if economies are highly open to both international trade and international finance. This implies not only substitutability in the roles of financial openness and financial development in economic development but also an accompanying high degree of vulnerability to international shocks.

As argued this study provides a first view at the dependence of the FG nexus on financial openness. It appears worthwhile to address in future research if more sophisticated, continuous measures of financial openness offer better insights into the joint importance of financial development and financial openness for the long-run linkage between finance and growth. As a second direction of future work one may consider to trace back the diagnosed state dependence that characterizes the FG nexus to institutional settings across economies. Similar to the heterogeneity of government expenditure (for e.g. compensation of government employees or expenditure related to securing property rights), other factor variables are also highly aggregated measures that eventually hide important cross-section-specific characteristics of the FG nexus. For example, the employed measure of trade openness ignores the composition of goods exported by a particular economy. As a result, uncovering particular institutions that foster the FG nexus is of high importance for issues in development policy.

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Appendix

A Semiparametric modeling

A.1 Estimation

We apply a semiparametric estimator of $\boldsymbol{\beta}(\omega)$ similar to the Nadaraya-Watson estimator (Nadaraya, 1964; Watson, 1964) which is given by

$$\hat{\boldsymbol{\beta}}(\omega) = X^{-1}(\omega)Y(\omega), \tag{6}$$

where $X(\omega) = \sum_{i=1}^{N}\sum_{t=1}^{T}\tilde{x}_{it}\tilde{x}'_{it}K_h(\omega_{it} - \omega)$ and $Y(\omega) = \sum_{i=1}^{N}\sum_{t=1}^{T}\tilde{x}_{it}\tilde{y}_{it}K_h(\omega_{it} - \omega)$, $K_h(\cdot) = K(\cdot/h)/h$, with $K(.)$ being a kernel function and h the bandwidth parameter. In this study, $K_h(\cdot)$ is the Gaussian kernel, $K(\cdot/h) = (2\pi)^{-1/2}\exp(-0.5(\cdot/h)^2)$. To select the bandwidth h, we apply Scott's (1992) rule of thumb, $h = 1.06\hat{\sigma}_\omega(NT)^{-1/5}$, where $\hat{\sigma}_\omega$ is the estimated standard deviation of the factor observations. Note that $\hat{\sigma}_\omega$ approximately equals to unity as we standardize the factors.

A.2 Inference

For inferential purposes, we follow the factor-based bootstrap approach of Herwartz and Xu (2009) that contrasts the factor invariant coefficient model with the state dependent model. Herwartz and Xu (2009) suggest two types of tests for factor dependence, global and local. The global test is a bootstrap approximation of an F-statistic and contrasts the residual sum of squares under the factor dependent model to that under invariant coefficients. The local test on the other hand examines the factor dependence for a given value of the factor. Confidence intervals under the null of a factor invariant FG nexus are constructed using bootstrap FG nexus estimates $\hat{\boldsymbol{\beta}}^*(\omega)$ obtained by means of pseudo samples ω_{it}^* of factors that are drawn with replacement from the given factor variables ω_{it} keeping other variables unchanged. This bootstrap resampling scheme destroys any systematic relationship between the model parameters and ω_{it}^*. For any local point ω, if an estimate $\hat{\beta}_1(\omega)$ lies outside its 95% confidence interval (based on 1000 bootstrap replications), then we reject the null hypothesis of constant FG nexus at 5% level of significance.

B List of economies included in each sample

B.1 Low-income economies

Burkina Faso, Burundi, Cameroon, Cote d'Ivoire, Gambia, Ghana, India, Kenya, Lesotho, Madagascar, Nepal, Niger, Nigeria, Pakistan, Papua New Guinea, Rwanda, Senegal, Sierra Leone, Togo.

B.2 Lower middle income economies

Algeria, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Guatemala, Honduras, Paraguay, Philippines, South Africa, Sri Lanka, Suriname, Swaziland, Syrian Arab Republic, Thailand.

B.3 Upper middle income economies

Botswana, Chile, Costa Rica, Gabon, Malaysia, Malta, Mauritius, Mexico, Saudi Arabia, Seychelles, St. Vincent and the Grenadines, Trinidad and Tobago, Uruguay, Venezuela.

B.4 High-income economies

Australia, Austria, Bahamas, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Republic of Korea, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, United Kingdom, United States of America.

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