Essays on Fiscal Policy, Public Debt and Financial Development

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To my family and friends

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Alfredo Schclarek Curutchet

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Chapter 1

Introduction

This thesis consists of three distinct articles that can be read separately. Each one has been awarded a chapter of its own. The independence of these chapters should not be taken as meaning that they are unrelated. Besides belonging all to the subfield of macroeconomics, they share the common feature of being inherently economic policy oriented. My opinion is that a PhD thesis is an opportunity to learn how to perform academic research, but this research should also have a meaning for the society. It is my impression that economists many times choose complicated and abstract topics for research, not for advancing the economic understanding of societies, but for the sole pleasure of solving complicated problems. This point has probably been aggravated by the profession's obsession for complicated mathematical models. The loss of contact with reality is obviously dangerous for any scientific discipline. However, this is especially relevant for macroeconomics which conclusions affect so many people simultaneously. With this in mind, I have tried to find research topics that are closely related to real problems and questions.

The general inspiration for choosing the topics of the three articles comes from analyzing the mainstream economic policy debate, and the realization of how influential this debate has been in the practical implementation of policies and reforms during the last 30 years. Since the academic triumph of Friedman and Lucas over Keynesianism, the mainstream economic policy debate has tended to favor laissez-faire policies and "market-oriented" reforms over economic interventionism. Although this shift may not be wrong per se, it is worrying that it has occurred very fast without an open and democratic debate. An example of the undemocratic tendencies I have noticed is that many arguments of the debate have been mostly based on empirical evidence for the US and OECD countries, with scarce evidence from other countries. This concern becomes even more appalling when recognizing that many of the policies and reforms that the debate suggests have been vigorously implemented in underdeveloped countries, a classic example being Argentina during the 1990's. Needless to say, in most of these underdeveloped countries, the application of these laissez-faire policies and "market-oriented" reforms has been decided by the political elites without the real involvement of the general public. Many times it has been a consequence of the conditionality imposed by the Group of 7 and international financial institutions (IMF, World Bank, etc) for granting new loans and foreign aid. In my opinion, policy advice should not be carried out without having a lot of evidence that considers the particular characteristics of the country in question. In any case, if previous evidence does not exist, one should be very careful when giving advice and a great dose of humility is necessary. I do not believe that this has been the case in Argentina during the 1990's and early 2000's.

Regarding the particular topics of each article, the inspiration comes from different episodes occurring in Argentina during the 1990's and early 2000's. Although the selection of topics has been motivated by different events from Argentina, the articles are not focused in analyzing the particular case of Argentina. The first two articles, which are eminently empirical in character, use data for both OECD and underdeveloped countries. I have contrasted the results from the data by dividing the sample of countries in sub-samples, obeying to development stages and geographical regions. The third article represents, what I believe is, a step forward in the quality of my research because it is a completely theoretical article. The approach has been to express my theoretical ideas through a mathematical model, following the standard approach in "modern" theory building. In what follows, I present the specific events that were decisive in the election of topics for each article. A brief presentation of the content and conclusions for each article is also presented.

The first article is motivated by the policy debate, and eventually the policy decision, that took place when Argentina entered into recession after the devaluation of the real in Brazil in 1999. This recession lasted for 3 years, and ended up ultimately in the complete collapse of the economy, with the worst financial and currency crises in Argentina's history. Although the fixed exchange rate bears a lot of responsibility for the crisis, the inability to get out of the recession, and its severity, are also important factors explaining the crisis. Why didn't Argentina implement a countercyclical fiscal policy to get out of the recession, as standard Keynesian policy suggests? Why did Argentina, on the contrary, implement a contractionary fiscal policy? The answer is that it was argued that fiscal policy becomes ineffective when the existing public debt is large, as was the case for Argentina. Moreover, it was even argued that a contractionary fiscal policy would have expansionary effects on the economy, i.e. fiscal policy would have non-Keynesian effects. However, these statements were grounded on scarce empirical evidence, which on top of that, were based on the experience of OECD countries. No evidence was available for underdeveloped countries. It is with this background that my first paper seeks to elucidate weather fiscal policy have Keynesian or non-Keynesian effect by not only using data for OECD countries but also for underdeveloped countries.

The title of the first article is "Fiscal Policy and Private Consumption in Industrial and Developing Countries" and has been accepted for publication in the Journal of Macroeconomics (tentatively scheduled for Volume 29, Number 4 (December 2007)). It empirically studies the effects of fiscal policy shocks on private consumption. Further, it investigates if the initial financing needs of the government or previous fiscal deficits affect that relationship. I use yearly data between 1970 and 2000 for forty countries, of which 19 are industrialized and 21 are underdeveloped. In general, the estimation results seem to indicate that government consumption shocks have Keynesian effects for both industrial and underdeveloped countries. In the case of tax shocks, the evidence is mixed. Furthermore, there is no evidence that favor the hypothesis of expansionary fiscal consolidations (non-Keynesian effects).

The second article is motivated by the default on the public debt that took place in Argentina after the crises of 2001. The crisis signified the abandonment of the fixed exchange rate, which led to a huge depreciation of the peso. As much of the public debt was denominated in foreign exchange (predominantly US dollars), the public debt surged to more than 150% of GDP in 2002. It was clear that a certain reduction in the stock of the public debt was necessary. During the renegotiation of the public debt, it was argued that without a substantial "haircut", Argentina would have growth problems in the near future. Different thresholds for a "sustainable" debt, as percentage of GDP, were mentioned. However, in reality, little understanding exists on how public debt affects growth, which are "sustainable" levels, and through which channels (capital accumulation, TFP growth, savings rates, etc) public debt affects economic growth. My article is a contribution to clarify these questions.

"Debt and Economic Growth in Developing and Industrial Countries" is the title of this, second, article. It empirically explores the relationship between debt and growth for a number of underdeveloped and industrial economies. For underdeveloped countries, we find that lower total external debt levels are associated with higher growth rates, and that this negative relationship is driven by the incidence of public external debt, and not by private external debt. Regarding the channels through which debt accumulation affects growth, we find that this is mainly driven by inhibiting capital accumulation. We find only a weak connection between external debt and total factor productivity growth. In the case of private savings rates, the results are mixed. In addition, we do not find any support for an inverted-U shape relationship between external debt and growth. For industrial countries, we do not find any significant relationship between gross government debt and economic growth.

The third article is related to the debate on how to strengthen the financial system. During the 1990's, and especially after the "tequila" crisis in 1995, Argentina fostered the establishment of foreign banks in the local market. Although most of these foreign banks simply bought already existing domesticowned banks, it was argued that this measure would make the financial system stronger and reduce the volatility of the economy. The behavior of foreign-owned banks before the banking crisis of 2001 showed that this statement was flawed. "Foreign" banks acted in no different way than "domestic" banks. Taking into consideration this experience, the last article of this thesis suggests an alternative hypothesis on what makes financial systems stronger. My argument is that the deepness of the financial system is closely related to the degree of diversification of the productive sector. Countries that have more diversified productive sectors have stronger financial systems.

The title of the third article is "Industry Diversification, Financial Development and Productivity-Enhancing Investments". It theoretically studies the role of the financial system in promoting macroeconomic stability and growth. It also explains endogenously the development of the financial system as part of the growth process. The productive sector engages in R&D activities, and finances its activities through access to the financial system. While vertical innovation spurs economic growth, horizontal innovation creates new industry sectors, and thus enhances industry diversification. Higher industry diversification deepens the financial system by improving its ability to finance the productive sector. Economies that are more diversified, and thus more financially developed, have higher growth rates and are less volatile. There is a role for the government to subsidize innovation, especially horizontal innovation.

Chapter 2

Fiscal Policy and Private Consumption in Industrial and Developing Countries

Forthcoming in *Journal of Macroeconomics.*

2.1 Introduction

Since the paper by Giavazzi and Pagano (1990), there has been a resurgence in the debate on the effects of fiscal policy on economic activity. Specifically, there have been a growing number of empirical studies that claim that under special circumstances contractionary fiscal policy may have expansionary effects on consumption, investment and/or output, i.e. fiscal policy has non-Keynesian effects. The most cited papers within this strand of the literature are Giavazzi and Pagano (1990), Giavazzi and Pagano (1996), Perotti (1999) and Giavazzi et al. (2000). However, there is also a growing number of studies that reject the non-Keynesian hypothesis, and claim that one should not generalize the results by Giavazzi and Pagano (1990). Among these papers one could mention, among others, Hjelm (2002a), Hjelm (2002b) and van Aarle and Garretsen (2003). Clearly, the empirical results are mixed and the debate is not set yet.

On top of these mixed results, most of the cited papers have mainly focused on the experience of industrial countries. Therefore, there is little evidence that guarantees that the experience of industrial countries can be applied to developing countries. Fortunately, there is an increasing interest to include the experience of developing countries in this debate (Gavin and Perotti, 1997). So far, however, the amount of research on developing countries is limited. An exception is Giavazzi et al. (2000), who find mixed evidence about the non-Keynesian effects of fiscal policy in developing countries. Thus, more research should be done in order to include developing countries.

The present work has two objectives. The first objective is to scrutinize the work of Perotti (1999) by mimicking his work but with a more updated data set.[1] Secondly, include to this analysis a sample of developing countries. Therefore, we will empirically investigate the effects of fiscal policy on private consumption for both industrial and developing countries. Specifically, we will try to determine whether fiscal policy has Keynesian or non-Keynesian effects on private consumption, and if this relationship is affected by the initial conditions of the economy, such as the financing needs of the government or previous fiscal deficits. The econometric methodology, which is the same as in Perotti (1999), is based on IV GMM panel data estimation, using a yearly panel of forty countries, of which 19 are industrialized and 21 developing countries.[2] Further, the data spans between 1970 and 2000. The source of the data is mainly the World Development Indicators database from the World Bank.

The rest of the paper is organized in seven sections. Section 2.2 presents a short survey of the empirical literature. The theoretical model used as a basis for the empirical research is briefly described in section 2.3. The empirical methodology and the data used are discussed in sections 2.4 and 2.5 respectively. Section 2.6 presents the estimation results for the whole sample, the sample of industrial countries and the sample of developing countries. In section 2.7, we discuss and present the results for some consistency test that were made in order to confirm the results of the benchmark case. Finally, section 2.8 concludes.

2.2 Survey of the literature

The literature that has evolved since the paper by Giavazzi and Pagano (1990), have mainly tried to answer whether fiscal policy has Keynesian or non-Keynesian effects on economic activity. Further, it has tried to answer under which special conditions fiscal policy has non-Keynesian effects. According to this branch of the economic literature, the impact of fiscal policy depends on: (i) the sign of the impulse (budget cut or expansion); (ii) its size and duration; (iii) the initial conditions (previous level or rate of growth of public debt, preceding exchange rate and money supply movements); (iv) the composition of the impulse (changes in taxes and transfers relative to changes in government consumption, changes in public investment or in social security entitlements).

Hemming et al. (2002) make an extensive survey of the theoretical and empirical literature on the effectiveness of fiscal policy in stimulating economic activity. They conclude that in general fiscal policy has Keynesian effects on economic

[1] Perotti (1999) uses a data set that includes 19 OECD countries over the period 1965 and 1994.

[2] We use the same sample of industrialized countries that in Perotti (1999).

activity but that the multiplying effect is small. Further, they acknowledge the possibility of non-Keynesian effects. In what follow we will extend the review of the empirical literature made by Hemming et al. (2002) in order to incorporate the latest results within the field. Specifically, we will concentrate our survey on those papers that examine cross section of countries in order to determine the existence, or not, of expansionary fiscal contractions. In general, the latest studies tend to cast doubts about the generality of the expansionary fiscal contraction hypothesis.

Table 2.1 summarizes the main conclusions from the surveyed papers. In this table we have also included the results of Giavazzi and Pagano (1996), Perotti (1999), and Giavazzi et al. (2000), which are the most cited articles in the empirical literature. The main conclusions of the surveyed new studies for industrial countries are as follow:

- The evidence tends not to support the expansionary fiscal contraction hypothesis. The only exception is Jönsson (2004), who finds that when fiscal contractions, in terms of public transfers, are large and persistent, there are non-Keynesian results. All the other studies obtain results that favor the view that fiscal policy has Keynesian effects.

- Regarding the sign of the impulse, the evidence seems to favor the asymmetry between contractions and expansions. Hjelm (2002b) find that private consumption grows less during contractions compared to normal periods and that there is no difference between expansions and normal times. In addition, Jönsson (2004) finds non-Keynesian effects for public transfers during contractions and Keynesian effects during expansions.

- Initial conditions are not important with the exception of the preceding exchange rate movement. Hjelm (2002a) and Hjelm (2002b) find that contractions preceded by real depreciations improve consumption growth compared to contractions preceded by real appreciations.

- With respect to the composition of the impulse, the evidence is mixed. While van Aarle and Garretsen (2003) find that public transfers have clearer Keynesian effects than government spending and taxes, Jönsson (2004) finds that public transfers have non-Keynesian effects during contractions. Further, Hjelm (2002b) concludes that the composition is not important.

- van Aarle and Garretsen (2003) conclude that the findings for private consumption can be extended to private investment, i.e. fiscal policy has Keynesian effects on investment.

Concluding, we can say that the fact that there have been episodes of expansionary fiscal contractions, and that some episodes share certain characteristics is not rejected. However, the surveyed papers cast doubts about the generality of these results. Furthermore, as the paper by Hjelm (2002a) shows, the preceding exchange rate movement is a key element for fiscal contractions to become successful. The most cited examples of successful expansionary fiscal contractions, namely Denmark (1982-1986) and Ireland (1987-1989), where all preceded by real exchange rate depreciations. Thus, it is possible that it was the real exchange rate depreciation that caused the consumption growth rather than the contractionary fiscal policy.

When considering the effects of fiscal policy for developing countries, the evidence is limited to the work of Giavazzi et al. (2000). Giavazzi et al. (2000) find evidence of non-linear effects of fiscal policy on private savings during large changes in the surplus. Furthermore, when large changes in the surplus are preceded by rapid debt growth, they even find non-Keynesian effects of taxes on private savings.

2.3 Theoretical Model

In this section we will briefly outline the theoretical model that we will use as point of reference for our empirical investigation. For a detailed treatment of the theoretical model we make reference to Perotti (1999). The model has four basic assumptions: first, taxes have distortionary effects; second, the government has a higher discount rate than private agents, and thus the economy is initially away from a perfect tax-smoothing situation; third, there are two kinds of private agents in terms of the access to the credit market, unconstrained individuals and constrained individuals; fourth, government consumption has positive effects on economic output.

There is a fraction $1-u$ of unconstrained individuals, which have perfect access to the credit market. The fraction u of constrained individuals have no access to the credit market. Both kinds of agents live for three periods. The model study the change in their consumption between periods 0 and 1 due to a fiscal shock in period 1. Further, the response of the fiscal policy in period 2 will depend on the fiscal shock in period 1. Therefore, fiscal policy shocks will have wealth effects from anticipated future responses of fiscal policy for unconstrained individuals. Conversely, constrained individuals will have no wealth effects and their change in consumption between periods 0 and 1 will be completely determined by their current income, which in turn is affected by the fiscal shock.

Further, L_t is the PDV of the financing needs of the government, which is determined by the intertemporal government budget constraint. Moreover, p is the probability that the policy-maker currently in charge of the government stay in office in the next period. The case when L_t is low or p is high is denominated good times, and the opposite situation is called bad times. According to this model, government consumption shocks have positive effects on private consumption at low levels of L_0, the PDV of the financing needs from the perspective of time 0, and negative effects at high levels of it. Similarly, government consumption shocks have positive effects at high levels of p and negative effects at low levels of it. In the case of tax revenue shocks, the model predicts that the tax shocks have the opposite effects on private consumption than the government consumption shocks. Therefore, tax shocks have negative effects at low levels of L_0, or high levels of p, and positive effects at high levels of L_0, or low levels of p. These predictions of the model will be the null hypothesis that we will empirically test. Further, the empirical model for testing the null hypothesis will be presented in the next section.

2.4 Specification and Estimation Methodology

The empirical model that we will estimate is a two-step econometric model. In the first step we will estimate the fiscal policy innovations and the expected change in disposable income for each country at the time. Then we will use the generated regressors to estimate the structural equation, which is the model we are interested in, through panel data estimation. We will have two structural equations or second-step models, the first that reflects the fiscal policy effects on consumption for both constrained and unconstrained individuals, and the second that only reflects the effects on unconstrained individuals. The first structural equation or second-step model is

$$\Delta C_{it} = \gamma_1 \hat{\epsilon}_{it}^G + \tilde{\gamma}_1 D_{it} \hat{\epsilon}_{it}^G + \gamma_2 \hat{\epsilon}_{it}^T + \tilde{\gamma}_2 D_{it} \hat{\epsilon}_{it}^T + \mu \Delta \hat{Y}_{it/t-1} + \omega_{it} \tag{2.1}$$

where ΔC_{it} is the change in private consumption for country i at time t, $\hat{\epsilon}_{ti}^G$ is the estimated government consumption shock, $\hat{\epsilon}_{it}^T$ is the estimated tax revenues shock, D_{it} is a dummy variable, which will take the value 0 in good times and the value 1 in bad times, $\Delta \hat{Y}_{it/t-1}$ is the estimated change in disposable income using information at time $t-1$, and ω_{it} is the error term.

The coefficient γ_1 measures the effects of government consumption shocks on the consumption of both constrained and unconstrained individuals. The case when $\gamma_1 > 0$ is referred as Keynesian effects of government consumption shocks on private consumption because a positive government consumption shock has a positive effect on private consumption. Conversely, when $\gamma_1 < 0$ we say that government consumption shocks have non-Keynesian effects on private consumption. $\tilde{\gamma}_1$ represents the difference in the effects of government consumption between bad and good times. Therefore, if $\tilde{\gamma}_1$ is negative and larger, in absolute value, than γ_1, we have non-Keynesian effects in bad times. Regarding the tax shocks, when γ_2 has a negative sign it means that a tax shock has a negative effect on private consumption. In this case, $\gamma_2 < 0$ is referred as Keynesian effects and $\gamma_2 > 0$ as non-Keynesian effect on private consumption. $\tilde{\gamma}_2$ measure the difference in the effects of tax shocks between good and bad times. Therefore, if the sum of γ_2 and

$\tilde{\gamma}_2$ is positive, tax shocks have non-Keynesian effects on private consumption in bad times. Clearly, the expansionary effects of fiscal consolidations occur when $\gamma_1 + \tilde{\gamma}_1 < 0$ and/or $\gamma_2 + \tilde{\gamma}_2 > 0$. Note that if both γ_1 and $\tilde{\gamma}_1$ are positive and/or both γ_2 and $\tilde{\gamma}_2$ are negative, we have Keynesian effects both in good and bad times. In addition, according to the theoretical model, μ reflects the share of credit constrained individuals (Perotti, 1999).

Under the null hypothesis $\gamma_1 > 0$, $\tilde{\gamma}_1 < 0$, $\gamma_2 < 0$, and $\tilde{\gamma}_2 > 0$. Therefore, the null hypothesis states that fiscal policy innovations have normally Keynesian effects on private consumption ($\gamma_1 > 0$ and/or $\gamma_2 < 0$), but that the Keynesian effects are reduced in bad times ($\tilde{\gamma}_1 < 0$ and/or $\tilde{\gamma}_2 > 0$). Moreover, in the case that $\gamma_1 + \tilde{\gamma}_1 < 0$ and/or $\gamma_2 + \tilde{\gamma}_2 > 0$, the Keynesian effects are completely reverted in bad times and therefore fiscal policy shocks have non-Keynesian effects, i.e. the expansionary effects of fiscal consolidations.

The second structural equation, which reflects the fiscal policy effects on consumption but only for unconstrained individuals, is

$$\Delta C_{it} = \gamma_1^u \hat{\epsilon}_{it}^G + \tilde{\gamma}_1^u D_t \hat{\epsilon}_{it}^G + \gamma_2^u \hat{\epsilon}_{it}^T + \tilde{\gamma}_2^u D_t \hat{\epsilon}_{it}^T + \mu \Delta \hat{Y}_{it/t} + \tilde{\omega}_{it} \tag{2.2}$$

where $\Delta\hat{Y}_{it/t}$ is the forecasted change in disposable income for country i using information at time t. Also the superscript u reflects the fact that we are only analyzing the effects of fiscal policy shocks on credit unconstrained individuals. Therefore, this alternative approach permits us study the wealth effects of unconstrained individuals which is the source of the non-Keynesian effects of fiscal policy. Note that the difference between equations (2.1) and (2.2) is that the first use $\Delta\hat{Y}_{it/t-1}$ while the second use $\Delta\hat{Y}_{it/t}$. As will become clearer in section 2.5, the difference between $\Delta\hat{Y}_{it/t-1}$ and $\Delta\hat{Y}_{it/t}$ is that the later use both lagged information on disposable income *and* the contemporaneous estimated fiscal policy innovations. Therefore, $\Delta\hat{Y}_{it/t}$ incorporates the effects of fiscal shocks on the disposable income of credit constrained individuals, and thus the coefficients of the fiscal innovations in equation (2.2) reflects only the wealth effects on consumption for unconstrained individuals.[3] The coefficients γ_1^u and γ_2^u measure the effects of government consumption shocks and tax shocks for unconstrained individuals respectively. In addition, $\tilde{\gamma}_1^u$ and $\tilde{\gamma}_2^u$ measure the difference in the effects of government consumption shocks and tax shocks between good and bad times respectively.

Under the null hypothesis $\gamma_1^u < \gamma_1$, $\tilde{\gamma}_1^u = \tilde{\gamma}_1 < 0$, $\gamma_2^u > 0 > \gamma_2$, and $\tilde{\gamma}_2^u > \tilde{\gamma}_2 > 0$. The null hypothesis states that during normal times a government consumption shock will have a milder effect on the consumption of unconstrained individuals than when taking into account both kinds of individuals ($\gamma_1^u < \gamma_1$).[4] The reason is that unconstrained individuals decide their present consumption

[3]See Perotti (1999) page 1414 for the formal demonstration.

[4]Note that $\gamma_1 = \gamma_1^c + \gamma_1^u$, where γ_1^c is the effect on credit constrained individuals and γ_1^u is the effect on unconstrained individuals.

taking into account the PDV of income, and not only their present income as credit constrained individuals do. Therefore, when government consumption increase, unconstrained individuals also take into account that in the future the tax revenues of the government will have to increase to finance the current increase in government consumption, thus having a negative wealth effect. $\tilde{\gamma}_1^u$ is equal to $\tilde{\gamma}_1$ because it is only unconstrained individuals that react differently between bad and good times. Mathematically, $\tilde{\gamma}_1^c = 0$, and thus $\tilde{\gamma}_1 = \tilde{\gamma}_1^u$ because $\tilde{\gamma}_1 = \tilde{\gamma}_1^c + \tilde{\gamma}_1^u$. Further, it states that these coefficients are negative, because government consumption shocks have non-Keynesian effects on unconstrained individuals' consumption in bad times. Next, the reason for γ_2^u being positive is that if current taxes rise, future taxation is reduced, at the same time that the expected PDV of taxation is constant. Recalling that the theoretical model assumed that taxes are distortionary, less taxes in the future implies less tax distortions, and thus the wealth of unconstrained individuals increase. Further, $\tilde{\gamma}_2^u > \tilde{\gamma}_2 > 0$ because $\tilde{\gamma}_2 = \tilde{\gamma}_2^u + \tilde{\gamma}_2^c$ and $\tilde{\gamma}_2^c < 0$.

Both equation (2.1) and (2.2) were estimated using two alternative definitions for the dummy variable. In addition, they were estimated for the whole country sample but also for the sub-sample of industrialized countries and the sub-sample of developing countries. The estimation method that was used was the same as in Perotti (1999). Equation (2.2) was estimated with an IV GMM estimator that allows for serial correlation of order 1 and heteroskedasticity of general form, using the panel equivalent of the Newey-West variance covariance matrix.[5] When using the IV GMM estimator for equation (2.2), ΔY_{it} was the endogenous regressor that is being instrumented, and $\Delta\hat{Y}_{it/t}$ was the instrument. Equation (2.1) was estimated with $\Delta\hat{Y}_{it/t-1}$ as an exogenous regressor, i.e. it was its own instrument. In all the regressions we included year dummies to account for any time-specific effects, i.e. we had a two-way error component regression model.

As noted earlier, $\hat{\epsilon}_{it}^G$, $\hat{\epsilon}_{it}^T$, $\Delta\hat{Y}_{it/t-1}$, and $\Delta\hat{Y}_{it/t}$ are generated regressors and are obtained from the expectation equations or first-step models presented in section 2.5 for each country at the time. According to McAleer and McKenzie (1991) the presence of generated regressors results in the covariance matrix of the disturbance term being non-spherical, with both non-zero off-diagonal and non-constant diagonal elements. Obviously, these poses a problem for our panel data estimation methodology, which unfortunately has no easy solution.[6] However, the estimation procedure that we used provides an efficient estimator (McAleer and McKenzie, 1991).[7] Moreover, as will be clearer when the empirical results

[5]We used the panel data version of the estimation command "ivreg2" with the "gmm robust bw(2) kernel(bartlett) small" options from the statistical software Stata 8.

[6]See, for example, Pagan (1984), Murphy and Topel (1985), McAleer and McKenzie (1991), and Smith and McAleer (1994).

[7]There are two broad procedures to correct the standard errors for the "generated regressor" problem. The first procedure implies applying a joint estimation method, such as full information maximum likelihood (FIML). The other alternative, which is the one employed in this

are presented, even if we use incorrect standard errors our main results cannot be invalidated.[8]

2.5 Data

The sample used for the estimation of the model consisted of a yearly panel of forty countries, of which nineteen were industrialized countries and twenty one were developing countries.[9] The election of the industrialized countries was made in order to compare the results of this study with prior studies, such as Perotti (1999). In the case of developing countries, the election of countries obeyed to the practical limitation of availability of data. The main source of the data for the different variables is the World Development Indicators database from the World Bank.[10] A detailed description of the different variables employed and sources for the data is presented in table 2.2. Further, the data spans from 1970 to 2000, i.e. there are 31 observations for each country. However, the bellow mentioned transformations of the data and estimation procedures reduced the span of the sample with four observations. Accordingly, the final panel used for estimating structural equations (2.1) and (2.2) consisted of a cross-section of 40 countries over 27 time periods, i.e. 1080 observations. In the case of the sub-sample for industrial countries our panel consisted of 513 observations. For developing countries, the sub-sample size was 567 observations.

All variables are scaled by the lagged value of disposable income. The reason for not using the standard scaling procedure, which uses the log value of the variable, is that there are large differences in government consumption-to-GDP and tax-to-GDP ratios across countries and over time. Obviously a change in government consumption will not have the same effects on private consumption if the government consumption-to-GDP ratio is 10% as when it is 30%. Therefore just

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study, is to use a two-step estimator. In this case, the standard errors from the second step need to be corrected. In this study, we have corrected the standard errors by allowing them to be serially correlated of order 1 and heteroskedastic.

[8]As Murphy and Topel (1985) show, the correct covariance matrix for the second-step estimators exceeds the unadjusted covariance matrix by a positive-definite matrix. Therefore, unadjusted standard errors are understated. In our case, and because in most cases we cannot reject the null of insignificant coefficients, this would imply that most of our coefficient would become even more insignificant.

[9]The industrialized economies are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom, and United States. Note that this is the same country sample used in Perotti (1999). The developing countries are Chile, Colombia, Costa Rica, Dominican Republic, Fiji, India, Malaysia, Malta, Mexico, Morocco, Pakistan, Panama, Paraguay, Philippines, South Africa, Sri Lanka, Thailand, Tunisia, Turkey, Uruguay, and Venezuela.

[10]While not as accurate and complete as data from the OECD Economic Outlook, using the WDI data for industrial countries allow us to compare better the results between industrial and developing countries.

scaling by the log difference is not appropriate in this case and all the variables are transformed using the following formula

$$\Delta X_t = [(X_t/N_tP_t) - (X_{t-1}/N_{t-1}P_{t-1})]/(Y_{t-1}/N_{t-1}P_{t-1})$$

where N_t is each countries' total population, P_t is the disposable income deflator, and Y_t is households disposable income. ΔX_t represents the change in the real per capita value of the variable X_t, divided by lagged real per capita disposable income Y_{t-1}.

As mentioned in section 2.4, the fiscal policy innovations $\hat{\epsilon}_{it}^G$ and $\hat{\epsilon}_{it}^T$ are not readily available and had to be estimated, i.e. they are generated regressors. We used a similar estimation method as the one employed by Perotti (1999). The fiscal policy shocks for each country were obtained from the following near VAR with government consumption, total tax revenue and GDP as the endogenous variables

$$\begin{aligned}
\Delta G_t &= \alpha_{1,0} + \alpha_{1,1}\Delta G_{t-1} + \alpha_{1,2}\Delta T_{t-1} + \alpha_{1,3}\Delta Q_{t-1} + \epsilon_t^G \\
\Delta T_t &= \alpha_{2,0} + \alpha_{2,1}\Delta G_{t-1} + \alpha_{2,2}\Delta T_{t-1} + \alpha_{2,3}\Delta Q_{t-1} + \epsilon_t^T \\
\Delta Q_t &= \alpha_{3,0} + \alpha_{3,1}\Delta G_{t-1} + \alpha_{3,2}\Delta T_{t-1} + \alpha_{3,3}\Delta Q_{t-1} + \alpha_{3,4}\Delta Q_{t-2} + \epsilon_t^Q
\end{aligned} \tag{2.3}$$

For each country we estimated the system of equations (2.3) and obtained the fiscal innovations from the residuals of each variable. However, we used a SUR estimation procedure that allowed for a non-common lag length structure. Accordingly, in order to obtain the lag structure for the SUR we added to the benchmark case two alternative lag structures. The first alternative specification added to the benchmark case ΔG_{t-2} to the list of regressors of the government consumption equation, and ΔT_{t-2} to the list of regressors of the tax equation. The second alternative specification added ΔQ_{t-2} to the first alternative specification for both the consumption and tax equations. Next, the highest adjusted R-square was used to identify the best lag structure for each variable (or equation of the SUR). Once we had identified the best lag structure for each variable from the three specifications, we constructed a new SUR where each equation had the best lag structure for each variable. In other words, the final system of equations was chosen so that for each equation the lag structure with the best specification was used.

The tax revenue shocks were cyclically adjusted following the methodology used by Perotti (1999). The cyclically adjusted tax innovations were computed as $\hat{\epsilon}_{it}^T - \phi_{it}\hat{\epsilon}_{it}^Q T_{it}$, where ϕ_{it} is the GDP-elasticity of taxes for each country and T_{it} is total tax revenues to previous year's per capita disposable income. Specifically, the elasticity ϕ_{it} is a weighted average of the elasticities of each component of total tax revenues, T_{it}.[11] The reason for cyclically adjusting the tax innovations is that we are only interested in the discretionary variations of the tax innovations

[11] ϕ_{it} changes for each year because the tax elasticity for each tax changes but also because the

and not the variations due to the business cycle. Further, the tax elasticities for industrial countries were taken from the OECD and are available in van den Noord (2000).[12] In the case of developing countries, there are no available GDP-elasticities of taxes. Therefore, for developing countries we used some pre-established elasticities for the different tax categories. These elasticities are taken from Chouraqui et al. (1990) and are the same that the OECD have used for those countries which lacked simulation-based elasticities. The elasticity values are 2.5 for corporate income taxes, 1.2 for personal income taxes, 1 for indirect taxes, and 0.5 for social security contributions. In section 2.7 we will change the assumed tax elasticity values and check whether the results from the benchmark case change. Specifically, we will have three alternative elasticity scenarios for developing countries. In the case of government consumption shocks, we have not cyclically adjusted them. The reason for not adjusting them is that generally there are no automatic feedback from economic activity to government purchases of goods and services.[13]

From section 2.4 it was clear that we needed to estimate both $\Delta\hat{Y}_{it/t-1}$ and $\Delta\hat{Y}_{it/t}$ to be used in equations (2.1) and (2.2) respectively. The difference between these forecasts is that $\Delta\hat{Y}_{it/t}$ do not only use lagged but also contemporaneous information. Consequently, $\Delta\hat{Y}_{t/t}$ was forecasted for each country at the time by using the following equation

$$\Delta Y_t = \beta_0 + \beta_1 \Delta Y_{t-1} + \beta_2 \hat{\epsilon}_t^G + \beta_3 \hat{\epsilon}_t^T + \varepsilon_t. \tag{2.4}$$

Similarly, $\Delta\hat{Y}_{t/t-1}$ was forecasted by estimating equation (2.4) but without the contemporaneous fiscal policy shocks. When estimating equation (2.4) for each country of the sample, we followed a Box-Jenkins strategy. We used the Schwarz criterion (SBC) to determine the correct model, i.e. the preferred lag structure was the one with the lowest SBC value. The diagnostic tests that were made are: a) serial correlation of residuals with correlogram - Q-statistics and LM test,

proportion of each tax relative to total tax revenues changes each year. In addition, the variable for direct taxes that we use (Taxes on income, profits and capital gains) include both corporate and personal income taxes. Therefore, for both industrialized and developing countries it was necessary to calculate the proportion of these two tax categories. The proportion for each year was taken from the Government Finance Statistics of the IMF.

[12]Note that these elasticities are not regression based elasticities, but are obtained from simulations that take into account the structure of the tax system of each country and on its distribution of earnings. Therefore, the cyclical component of the change in taxation is not a generated regressor. Furthermore, as pointed out by van den Noord (2000), it is not advisable to use elasticities obtained from regressions because they will internalize policy-induced effects on the budget, which could therefore be misleading.

[13]The only component of government *expenditure* that should be cyclically adjusted is unemployment benefit expenditures. However, this component is a relatively small component of government expenditures (Giorno et al., 1995), and it is not even included in the definition of government *consumption*. Furthermore, most developing countries do not even have unemployment benefit schemes.

b) normality of disturbances with Jarque-Bera, and c) heteroskedasticity with White test (cross terms).[14]

In the case of the empirical construction of the regime dummy variable, D_{it} take the value 0 in good times and the value 1 in bad times. Further, as in the theoretical model in section 2.3, we used two different definitions of bad times. $D1_t$ was used as proxy for L_0 (the PDV of the financing needs of the government) and $D2_t$ for p (the probability that the policy-maker be reelected), and we defined these variables as Perotti (1999). In the first definition, $D1_t$, we use the sum of government debt at time $t-1$ and the PDV of future government expenditure as a share of potential output to define bad times.[15] Specifically, a given country-year t belongs to the bad time regime if the ratio is greater than a certain cutoff value x. For the benchmark case, we will define the cutoff value x as the eightieth percentile of the ratio's distribution, generating $D1_t(.80)$. As will be seen in section 2.7, we will have two alternative definitions for $D1_t$, one with a threshold value given by the ninetieth and seventieth percentile, generating $D1_t(.90)$ and $D1_t(.70)$ respectively.

In the second definition of bad times, $D2_t$, we use the fiscal deficit as a proxy for the reelection probability. As Perotti (1999) stresses, the reason for using the fiscal deficit is that it captures the extent of the departure from perfect tax-smoothing. It is expected, due to political economy reasons, that a lower probability of reelection will induce the policy maker to follow a less responsible fiscal policy, i.e. a larger fiscal deficit. Therefore, a given country-year t belongs to the bad time regime if the "cyclically adjusted" deficit as a ratio of potential output exceeds a certain value x in the two previous years $t-1$ and $t-2$.[16] For the $D2_t$ variable we will have the following values 4%, 6%, and 8%, i.e. $D2_t(.04)$,

[14]For some countries we had to exclude some outlier observations, due to wars or deep economic crises, in order to estimate the corresponding model. These outliers were detected because the normality test failed. In these cases only AR models could be tested because Eviews cannot estimate MA terms when there are missing observations within the sample. After estimation we included the excluded observations and therefore we could make one step forecasts for the whole sample, including the years that had been excluded. The countries were Malaysia (1998), Panama (1988), Philippines (1984), Greece (1974), Tunisia (1971-72), and Thailand (1998).

[15]We cyclically adjust government debt by subtracting the cyclical change in taxation relative to the previous year, as measured by the lagged percentage change in real GDP times the average GDP elasticity of taxes, $\tilde{B}_t = B_t - T_t\%\triangle GDP_{t-1}\phi_t$. The PDV of future government expenditure was calculated recursively from a near VAR similar to the system of equations (2.3) using an out-of-sample prediction of five years and a discount rate of 5%. For some developing countries, we used current GDP instead of potential output and Total government external debt due to data availability.

[16]Note that for the industrial countries the cyclically adjusted deficit is measured as the first difference in the cyclically adjusted government debt. In the case of the developing countries, we used the cyclically adjusted fiscal deficit. It was obtained by the following formula $\tilde{FD}_t = FD_t - T_t\%\triangle GDP_{t-1}\phi_t + T_{t-1}\%\triangle GDP_{t-2}\phi_{t-1}$. The reason for not using the debt variable is that for developing countries it just incorporates the external debt, and is thus not a good approximation for the public fiscal deficit.

$D2_t(.06)$, and $D2_t(.08)$ respectively. $D2_t(.06)$ is the benchmark case. In table 2.3, a list of the country-years that belong to the bad time regime according to the definitions of $D1_t(.90)$, $D1_t(.80)$, $D2_t(.06)$, and $D2_t(.04)$ are presented.

2.6 Estimation Results

2.6.1 All the Countries in the Panel

Table 2.4 shows the estimates of equation (2.1) in columns (1) and (2), and of equation (2.2) in columns (3) and (4) for all the countries in the sample. Thus, the estimated coefficients are the γ_i's and $\tilde{\gamma}_i$'s in columns (1) and (2) and γ_i^u's and $\tilde{\gamma}_i^u$'s in columns (3) and (4). The difference between columns (1) and (2) is that the dummy variable used is $D1_t(.80)$ and $D2_t(.06)$ respectively. The same apply to columns (3) and (4).

In columns (1) and (2) under the null hypothesis $\gamma_1 > 0$, $\tilde{\gamma}_1 < 0$, $\gamma_2 < 0$, and $\tilde{\gamma}_2 > 0$. From column (1) we see that all coefficients but γ_1 are not consistent with the null hypothesis when we use the first definition of bad times, $D1_t(.80)$. The coefficient for government consumption is 0.713 and significantly different from zero at the 1% level. Therefore, government consumption innovations have Keynesian effects on private consumption in good times. In addition, $\tilde{\gamma}_1$ is insignificantly different from zero and inconsistent with the null hypothesis. Thus, there are no difference in the Keynesian effects between good and bad times. In the case of the tax revenue shock, the coefficient is also insignificantly different from zero, which is not consistent with the null hypothesis. Moreover, $\tilde{\gamma}_2$ is also insignificant and therefore not according to the null hypothesis. Consequently, tax revenue innovations have no effects on private consumption in good times as well as in bad times.

When we use the second definition of bad times, $D2_t(.06)$, (column (2)), the coefficient for government consumption is significant and equal to 0.730. In addition, $\tilde{\gamma}_1$ is insignificantly different from zero. Thus, government consumption has Keynesian effects both in good and bad times. In the case of the tax variables, these are insignificant and not consistent with the null hypothesis. Therefore, tax revenue shocks have no effects on private consumption in good times as well as in bad times.

In the case of columns (3) and (4) the null hypothesis states that $\gamma_1^u < \gamma_1$, $\tilde{\gamma}_1^u = \tilde{\gamma}_1 < 0$, $\gamma_2^u > 0 > \gamma_2$, and $\tilde{\gamma}_2^u > \tilde{\gamma}_2 > 0$. Note that now the coefficients of fiscal shocks depict only the effects on unconstrained individuals. The reason is that the effects on constrained individuals is captured by $\Delta\hat{Y}_{t/t}$ as explained in section 2.4. In column (3) we see that only γ_1^u of the fiscal variables is consistent with the null hypothesis. Although the coefficient for government consumption is insignificantly different from zero, it is lower than the value of γ_1. Further, the coefficient for the difference between good times and bad times is not significant and not consistent with the null. In the case of the tax coefficients the results are not consistent with the null hypothesis. Both γ_2^u and $\tilde{\gamma}_2^u$ are not significantly different from zero. The results from column (4) are similar to those in column (3).

In summary, the results when using the whole panel seem not to be consistent with the null hypothesis. Specifically, government consumption shocks have Keynesian effects but there are no differences on its effects in bad times. In addition, tax revenue shocks seem not have any effects on private consumption irrespective of the initial conditions. In addition, when analyzing the results for unconstrained individuals, fiscal policy seem not to affect the consumption of these individuals. Moreover, there is no evidence that favor the hypothesis of expansionary fiscal consolidations.

2.6.2 Industrialized Countries

Table 2.5 shows the estimates of equations (2.1) and (2.2) for industrialized countries. We see from column (1) that only the coefficient for government consumption innovations is significantly different from zero with a positive value of 0.587. All the other coefficients are insignificantly different from zero and therefore not consistent with the null hypothesis. Note, however, that $\tilde{\gamma}_1$ is significant at the 10% level with a negative value of -0.553.[17] In the case of column (2), when using the dummy variable $D2_t(.06)$, the results are equivalent to the results of column (1). The coefficient for government consumption innovations is the only one that is significantly different from zero, with a positive value of 0.621.

When only considering the effects of fiscal policy innovations for unconstrained individuals and using dummy variable $D1_t(.80)$ (column (3)), all the coefficients are insignificantly different from zero. Therefore, only γ_1 is consistent with the null hypothesis, which for this coefficient is $\gamma_1^u < \gamma_1$. When considering unconstrained individuals and dummy variable $D2_t(.06)$ (column (4)), we corroborate the results of inconsistency with the null hypothesis of column (3). Note, however, that in this case, γ_1^u is significant at the 5% level, with a coefficient value of 0.424, which is less than the value of γ_1 and consistent with the null hypothesis.

In summary, for industrial countries the estimation results seem not to favor the null hypothesis. In the case of government consumption shocks, they seem to have Keynesian effects, which is consistent with the null hypothesis. However, these Keynesian effects are not reverted in bad times, which is inconsistent with the null hypothesis. Moreover, in the case of tax shocks there seems not to be any effects on private consumption, which is inconsistent with the null hypothesis. In addition, when analyzing the results for unconstrained individuals, there is some

[17] Due to the generated regressors issue described in section 2.4, we have decided to impose the 5% level as the cutting threshold for significance. Further, even in the case of considering this coefficient as significant, it is is not greater, in absolute terms, than γ_1, which is evidence against the hypothesis of expansionary fiscal consolidations.

evidence that government consumption shocks have a positive effect on their consumption. Thus, for industrial countries there is no evidence that support the hypothesis of expansionary fiscal consolidations.

These results are in stark contrast to the results of Perotti (1999), who for the same sample of industrial countries finds evidence that support the hypothesis of expansionary fiscal consolidations. Among the possible reasons for the discrepancy, the following two possibilities arise: a) different data source for some of the variables[18], and b) different year sample.[19] Note that we have used the same industrial country sample, the same estimation methodology and the same dummy variable definitions.[20] Of these two explanations, we favor the year sample hypothesis. The reason is that the WDI variables and the OECD Economic Outlook variables have a very high degree of correlation, which is indication that their evolution is very similar. For example, the household consumption, government consumption, direct taxes, indirect taxes variables have a correlation factor for each country of between 1 and 0.9967, 1 and 0.7857, 0.9983 and 0.9362, and 0.9997 and 0.9384 respectively.[21] Furthermore, we obtained similar results as those of Perotti (1999) when we restricted our data set to the years 1970 to 1994 and used the same country/year observations for bad times than Perotti (1999). On top of that, we replicated the results of Perotti (1999) when using the same data source for the different variables (OECD Economic Outlook) and the same year sample (1965 to 1994).[22]

2.6.3 Developing countries

In table 2.6 we see the results from estimating equations (2.1) and (2.2) for developing countries. In this case, column (1) shows that government consumption has a significant positive effect on private consumption with a value of 0.867 for γ_1. In the case of $\tilde{\gamma}_1$, it is insignificant showing that for developing countries there are no differences between good and bad times. In the case of the tax variable γ_2, it assumes a significant value at the 5 percent level of -0.296. In addition, the difference between good and bad times in the effects of tax revenues is insignificantly different from zero.

In the case when using the second definition of bad times, $D2_t(.06)$, the results are very similar to those in column (1). The coefficient γ_1 has a value of 0.867 and

[18]We used WDI data, instead of OECD Economic Outlook data as in Perotti (1999), in order to include developing countries.

[19]Our data sample spans between 1970 and 2000, instead Perotti (1999)'s data sample spans between 1965 and 1994.

[20]Note that, in the case of the dummy variable definitions, table 2.3 displays the country-years for the two definitions of bad times. Further, most of the bad times years identified by Perotti (1999) are also present in this table.

[21]The results for all industrial countries and variables are available upon request from the author.

[22]These results are available upon request from the author.

is consistent with the null hypothesis. Further, there are no differences between good and bad times. In addition, the estimate of the tax variable coefficient, γ_2, is significant at the 5 percent level with a value equal to -0.290. However, $\tilde{\gamma}_2$ is insignificantly different from zero.

When analyzing the wealth effects for unconstrained individuals in columns (3) and (4), none of the coefficients are significant. Therefore, only the results for γ_1^u are consistent with the null hypothesis. Thus, for unconstrained individuals fiscal policy has no effect on their consumption.

Concluding, the estimates for developing countries do not favor the null hypothesis. The innovations in government consumption have Keynesian effects on private consumption. Moreover, there are no differences on their effects between good and bad times. In the case of tax shocks, they also have Keynesian effects irrespective of the initial conditions. In addition, the estimation results for unconstrained individuals imply that they are not affected by fiscal policy shocks. Furthermore, there is no evidence that favor the hypothesis of expansionary fiscal contractions or non-Keynesian effects.

Comparing the results for industrial and developing countries, two interesting differences arise. First, the government consumption coefficient for developing countries is larger than that for industrial countries, meaning that government consumption shocks have larger Keynesian effects in developing countries. Second, for developing countries there is evidence of Keynesian effects for tax shocks, while there is none for industrial countries. Thus, in developing countries, governments can use an active tax policy to affect private consumption. A possible explanation for these two differences, which is consistent with the theoretical model of Perotti (1999), is that in developing countries there is a larger proportion of credit constrained individuals. The argument for this hypothesis can be seen when comparing the values for μ in tables 2.5 and 2.6. Clearly, the μ coefficient, which measures the proportion of constrained individuals, is greater in developing countries. Therefore, it is expected that γ_1 will assume a larger value in developing countries because γ_1 is a positive function of μ in the theoretical model. Conversely, γ_2 is a negative function of μ, and thus it is expected that γ_2 will be more negative in developing countries.[23]

2.7 Consistency Tests

In order to be sure that the results we obtained in section 2.6 are robust to the different underlying assumptions that were made, we carried out several consistency tests. The first consistency check that was made was to estimate both equation (2.1) and equation (2.2) using alternative threshold values for the definitions of bad times. For the $D1_t$ dummy variable, we used the threshold values

[23]The larger the share of constrained individuals, the smaller the weight of the negative wealth effect of expenditure shocks and of the positive wealth effect of tax shocks in the aggregate effect.

from the ninetieth and seventieth percentile to define bad times ($D1_t(.90)$ and $D1_t(.70)$). In the case of the budget deficit dummy variable, $D2_t$, we defined bad times using two alternative definitions. One with a threshold value of 8% and another with a 4% value ($D1_t(.08)$ and $D1_t(.04)$).

The second robustness check was to define two alternative definitions for the bad time dummy variables. Specifically, the first alternative definition defined bad times when the government debt-to-potential output ratio exceeds 80% ($D3_t(.80)$).[24] The second alternative dummy variable definition used the fiscal deficit as a ratio of potential output to determine bad times.[25] Specifically, a certain year t is defined as bad times if fiscal deficit-to-potential output ratio exceeds 6% in the two previous years $t-1$ and $t-2$ ($D4_t(.06)$).

Another consistency check that was made, was to obtain the fiscal policy shocks from a VAR methodology instead of the SUR methodology. Remember from section 2.5 that, using the same procedure as in Perotti (1999), the fiscal policy shocks were estimated as the residuals from the system of equations (2.3). Note that it is not only the estimated values of the fiscal policy shocks that change but also the estimated values of $\Delta\hat{Y}_{t/t}$ as the fiscal policy shocks are used in equation (2.4). Specifically, we checked if the results of the benchmark case changed if we use the estimation method suggested by Glick and Hutchison (1990). They suggest using a strictly VAR procedure to estimate the system of equations (2.3), where a common lag length structure is used for the three exogenous variables. Glick and Hutchison (1990) claim that the advantage of this procedure over the SUR procedure is that the results from the SUR procedure will in general depend on the particular order of variables in the sequence considered. The disadvantage is, however, that sometimes insignificant lags are included in the equation, which gives unbiased but less efficient estimators. In our case, common lag lengths between one and three were estimated for each country. Further, the VAR with the lowest value of the SBC criterion was chosen to estimate the fiscal policy shocks.

The fourth consistency check that was performed was to investigate whether the estimation results of equations (2.1) and (2.2) depended on the assumed tax elasticity values for non-OECD countries. Remember from section 2.5 that due to the lack of available tax elasticities for non-OECD countries, we assumed that non-OECD countries had some common tax elasticity values to calculate the cyclically adjusted tax revenue shocks. These elasticity values are the same that the OECD have used in their reports for those OECD countries that lack non-regression based elasticities. For this consistency test, we assumed three alternative scenarios for the tax elasticities of non-OECD countries. For the first alternative tax elasticity scenario, we assumed that non-OECD countries had an

[24]Note again that in the case of developing countries we used external government debt instead of total government debt, and GDP, instead of potential output.

[25]For both industrial and developing countries we used the fiscal deficit variable from the IFS, i.e. we did not define the fiscal deficit as the difference in government debt in two periods.

elasticity structure equal to the average elasticity values of Greece, Ireland, Portugal, and Spain, taken from van den Noord (2000). The average values are 1.1 for corporate taxes, 1.4 for personal income taxes, 0.8 for indirect taxes and 0.9 for social security contributions. The second alternative scenario assumed that non-OECD countries undertook, for each tax group, the highest elasticity value of Greece, Ireland, Portugal, or Spain (van den Noord, 2000). It assumed the following values: a) corporate taxes : 1.4 (Portugal); b) personal income taxes: 2.2 (Greece); c) indirect taxes: 1.2 (Spain); d) Social security contributions: 1.1 (Greece). The third alternative tax elasticity scenario adopted the highest tax elasticity value among all OECD countries from van den Noord (2000). It assumed the following values: a) corporate taxes: 2.1 (Japan); b) personal income taxes: 2.2 (Greece); c) Indirect taxes: 1.6 (Denmark); d) social security contributions: 1.2 (UK).

The last consistency check performed on the results of the benchmark case consisted in investigating whether any particular country had any disproportionate impact on the estimation results. The employed procedure was to compare the results of the benchmark case with the results of the same benchmark regression but excluding each country at the time. This estimation was carried out for both equations (2.1) and (2.2), and for both definitions of bad times. Further, it implied making as many regressions as countries existed in the benchmark sample, i.e. one regression for each excluded country.

None of the five consistency tests gave us substantial arguments to question the conclusions from the benchmark results of section 2.6. Tables 2.7 to 2.12 present the results for the first and second consistency tests for the three different country samples.[26] Interestingly, in the case of the first consistency test for the sample of all countries (table 2.7), the $\tilde{\gamma}_1$ coefficient in columns (2) and (5) becomes significant at the 5% and 1% level respectively. Both coefficients are larger in absolute terms than the γ_1 coefficient, and thus evidence of non-Keynesian effects. It is to be noted, however, that both γ_1^u and $\tilde{\gamma}_1^u$, which should be capturing the non-Keynesian effects are insignificantly different from zero. Further, when using the VAR methodology and the $D1_t(.90)$ dummy variable, $\tilde{\gamma}_1$ becomes insignificant. In addition, for the $D1_t(.90)$ dummy variable, $\tilde{\gamma}_1$ becomes insignificant when excluding Belgium, Mexico, Panama, Sweden, Turkey, and Venezuela from the sample (consistency test five).

Regarding the consistency tests for industrial countries, it is to be noted that when using the VAR methodology and for the $D1_t(.80)$ dummy variable, $\tilde{\gamma}_1$ becomes significant at the 5% level with a negative value of -0.645 (this table is not shown). This value is, however, not larger than the γ_1 coefficient, which has a value of 0.669 and is significant at the 1% level. Further, $\tilde{\gamma}_1$ (also for $D1_t(.80)$) becomes significant at the 5%, but not larger in absolute value than γ_1, when excluding Denmark.

[26] Tables for the other consistency tests are available upon request from the author.

When considering developing countries, from table 2.9 and for $D2_t(.08)$ (column (5)), we see that $\tilde{\gamma}_1$ becomes significant at the 5% level with a negative value of -1.065, larger than that for γ_1 (0.882). However, when performing consistency test 5 and considering $D2_t(.08)$, this coefficient becomes only significant at the 10% level when we exclude Venezuela. Further, both γ_1^u and $\tilde{\gamma}_1^u$, which should be capturing the non-Keynesian effects are insignificantly different from zero. Another minor difference with the benchmark case is that γ_2 becomes only significant at the 10% level when using dummy definitions $D1_t(.90)$ (table 2.9), $D3_t(.80)$ (table 2.12), when excluding South Africa and Sri Lanka from the sample for $D1_t(.90)$ (consistency test five), and when excluding Costa Rica, Pakistan, Paraguay, Philippines, Sri Lanka, and Venezuela for $D2_t(.06)$. Further, this coefficient becomes insignificant when considering the first alternative elasticity scenario both for the case of dummy variable $D1_t(.80)$ and $D2_t(.06)$.

2.8 Conclusions

The results from the estimations indicate that government consumption shocks have Keynesian effects on private consumption in industrial and developing countries. In addition, these Keynesian effects are not reverted in bad times. In the case of the tax shocks, the evidence suggest that for industrial countries they do not have any effects on private consumption either in good times or bad times. However, for developing countries, we find that tax shocks have Keynesian effects on private consumption. Accordingly, we show that for industrial countries the composition of fiscal policy shocks is crucial for stimulating private consumption. Contrary to the common belief that expenditure cuts, instead of tax increases, is crucial for a favorable macroeconomic outcome, we claim that the opposite is true. Further, we do not find that initial conditions are important in determining the outcome of fiscal policy. Thus, there is no evidence that favor the expansionary fiscal consolidation hypothesis (non-Keynesian effects). Finally, we find that government consumption shocks have a larger Keynesian effect on private consumption in developing countries than in industrial countries. This result is intuitive, and is consistent with the theoretical model introduced in section 2.3, if we consider that there is a larger proportion of credit constrained individuals in developing countries.

When comparing our results for industrial countries with Perotti (1999), we find markedly differences. He finds that the shocks in government consumption and taxes have Keynesian effects during good times, but non-Keynesian effects during bad times. However, he finds, in line with our findings, that the composition of fiscal policy is important. It is to be noted that we were able to replicate his findings when using the same time period that he used. Therefore, we conclude that the difference in our results is due to the different year sample used. Clearly, more investigation needs to be done with a wider data set to reach decisive conclusions. With regards to the other surveyed papers, our results are in line with Giavazzi et al. (2000), Hjelm (2002b) and van Aarle and Garretsen (2003) in the sense that initial conditions, with the exception of preceding depreciations, are not important. Moreover, our results regarding the rejection of the expansionary fiscal consolidation hypothesis are in line with Hjelm (2002a), Hjelm (2002b), and van Aarle and Garretsen (2003).

In addition, when comparing our results for developing countries with those obtained by Giavazzi et al. (2000), we do not reach completely to the same conclusions. It is to be noted, however, that they study the effects of fiscal policy on national saving and not private consumption as in our study. They conclude that during normal times both government spending and net taxes have Keynesian effects on national saving. However, during bad times the Keynesian effects of fiscal policy become milder, i.e. there are differences between good and bad times. Further, they find evidence of non-Keynesian effects for net taxes in bad times when using the deficit dummy variable.

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Table 2.1: Cross-section Studies of Fiscal Policy

Study	Sample	Special circumstances	No. episodes
Giavazzi and Pagano (1996)	19 OECD countries, 1970-1992	Size and persistence (ex ante): Any period when the cyclically adjusted primary deficit as a percentage of potential GDP had a cumulative change of 3 to 5%, depending on the number of years.	223
Perotti (1999)	19 OECD countries, 1965-1994	Initial conditions: the "cyclically adjusted" government debt and the PDV of future government expenditure, as a share of trend GDP in previous year, exceeds the ninetieth percentiles of the distribution and cyclically adjusted deficit, as a share of trend GDP, exceeds 4% for two consecutive years.	Not given
Giavazzi et al. (2000)	18 OECD countries, 1960-1996	Size and persistence (ex ante): a large and persistent fiscal impulse when full employment surplus (as a percent of potential output) changes by at least 1.5 percentage points per year over a two-year period. Initial conditions: gross public debt exceeds 70% of potential output in previous year and growth rate of the ratio of (cyclically adjusted) gross public debt to trend GDP exceeds 4% for two consecutive years.	38 expansions, 65 contractions
Hjelm (2002a)	19 OECD countries, 1970-1997	Size and persistence (ex ante): fiscal contraction period when the cyclically adjusted primary deficit as a percentage of potential GDP had a cumulative decrease of 3 to 5%, depending on the number of years. Initial conditions: Splits fiscal contractions with respect to REER and M2 during the preceding two years and during the contraction.	23 contractions
Hjelm (2002b)	19 OECD countries, 1970-1997	Size and persistence (ex ante): Any period when the cyclically adjusted primary deficit as a percentage of potential GDP had a cumulative change of 3 to 5%, depending on the number of years. Initial conditions: Splits fiscal contractions with respect to debt to GDP ratio of the preceding year, total growth in the debt ratio during the preceding two years and the preceding exchange rate movement (depreciation or appreciation).	55
van Aarle and Garretsen (2003)	14 EU countries, 1990-1998	Size and persistence (ex ante): Any period when the cyclically adjusted primary deficit as a percentage of potential GDP had a cumulative change of 3 to 5%, depending on the number of years. Initial conditions: Splits fiscal contractions with respect to debt to GDP ratio of the preceding year, total growth in the debt ratio during the preceding two years and the preceding exchange rate movement (depreciation or appreciation).	29
Jönsson (2004)	19 OECD countries, 1960-2000	Size and persistence (ex ante): Any period when the cyclically adjusted primary deficit as a percentage of potential GDP had a cumulative change of 3 to 5%, depending on the number of years.	23 expansions, 25 contractions
Giavazzi et al. (2000)	101 developing countries, 1970-1994	Size and persistence (ex ante): a large and persistent fiscal impulse when current surplus (as a percent of potential output) changes by at least 1.5 percentage points per year over a two-year period. Initial conditions: gross public debt exceeds 70% of potential output in previous year and growth rate of the ratio of (cyclically adjusted) gross public debt to trend GDP exceeds 4% for two consecutive years.	259 expansions, 270 contractions

Table 2.1: Cross-section Studies of Fiscal Policy *(continued)*

Study	Type of Analysis	Main Evidence of Expansionary Contractions	Channels	Characteristics
Giavazzi and Pagano (1996)	Panel regressions of consumption functions (error correction specification)	For large/persistent consolidations, $1 increase in taxes (cut in transfers) raises private consumption by 15-20c in long run.	Private sector consumption	Size and persistence most important, clearer effects for government spending but also for taxes and transfers.
Perotti (1999)	Panel regressions of consumption functions (Euler equation specification)	Expenditure shocks have Keynesian effects with low debt or deficit, but non-Keynesian effects with high debt or deficits; evidence on a similar switch with tax shocks is less strong.	Private sector consumption	.2Initial fiscal conditions are crucial; composition also important.
Giavazzi et al. (2000)	Panel regressions of national savings rates	Non-linear responses by private sector more likely when fiscal impulses are large and persistent. No evidence of non-Keynesian effects.	Private sector consumption/saving	Size and persistence most important, initial fiscal conditions not important. Non-Keynesian effects larger for changes in taxes than spending, and for contractions rather than expansions.
Hjelm (2002a)	Panel regressions of consumption functions (structural solved out specification)	No evidence of non-Keynesian effects.	Private sector consumption	Initial conditions: contractions preceded by real depreciations improve consumption growth compared to contractions preceded by real appreciations.
Hjelm (2002b)	Panel regressions of consumption functions (structural solved out specification)	No evidence of non-Keynesian effects.	Private sector consumption	Size and persistence is important: private consumption growth is lower during contractions compared to normal periods, no difference between expansions and normal periods. Composition not important. Initial conditions: consumption growth higher during contractions preceded by depreciations rather than appreciations; initial level of debt and deficits not important.
van Aarle and Garretsen (2003)	Panel regressions of consumption functions (error correction specification)	No evidence of non-Keynesian effects.	Private sector consumption/investment	Size and persistence not important. Initial conditions: initial level of debt not important. Clearer Keynesian effects for public transfers than government spending and taxes.
Jönsson (2004)	Panel regressions of consumption functions (error correction specification)	Non-Keynesian responses only for transfers and when fiscal impulses are large and persistent.	Private sector consumption	Size and persistence important, non-Keynesian effects only for public transfers during contractions; larger effects during contractions than expansions.
Giavazzi et al. (2000)	Panel regressions of national savings rates	Non-Keynesian responses only for tax changes when fiscal impulses are large and persistent and preceded by rapid debt growth.	Private sector consumption/saving	Size and persistence most important, initial fiscal conditions only important for debt growth. Non-Keynesian effects larger for changes in taxes than spending, symmetry between expansions and contractions.

Table 2.2: Variables and Sources

Variable	Series	Source
Private consumption	Household Final Consumption Expenditure	WDI
Government consumption	General Government Final Consumption Expenditure	WDI
Total tax revenue	Taxes on Income, Profits and Capital Gains + Social Security Taxes + Net Taxes on Products	WDI
Households disposable income	GNI	WDI
Gross domestic product	GDP	WDI
Disposable income deflator	GDP Deflator	WDI
Population	Population, total	WDI
Government external debt	External debt, total - Private nonguaranteed debt	WDI
Exchange rate	DEC alternative conversion factor	WDI
Government debt	Gross Government Debt	OECD
Fiscal deficit	Deficit (-) or surplus	IFS
Potential output	Potential GDP	OECD

WDI refers to the World Development Indicators 2002. IFS refers to the International Financial Statistics 2002. OECD refers to the OECD Economic Outlook 2002. For industrial countries, we used government debt, and for developing countries we used government external debt. For some countries Taxes on Goods and Services (WDI 2002) was used instead of Net Taxes on Products. All the series are expressed in local currency units.

Table 2.3: Bad Times

	(1) $D1(.90)$	(2) $D1(.80)$	(3) $D2(.06)$	(4) $D2(.04)$
Australia				
Austria		1994-2000	1977, 1995-1996	1977-1980, 1983-1989, 1995-1996
Belgium	1981-2000	1974-2000	1977, 1980-1989, 1992-1994	1975-1995
Canada	1991-2000	1985-2000	1983-1988, 1993-1994	1976-1979, 1982-1996
Chile		1987		1975
Colombia				2000
Costa Rica			1981	1981, 1996
Denmark	1983-1987, 1989-2000	1982-2000	1980-1985	1980-1985, 1993-1995
Dominican Republic				
Fiji			1998	1978, 1983-1984, 1993-1995, 1998-1999
Finland		1996-2000	1993-1996	1993-1997
France		1994-2000	1994	1994-1997
Germany				1977, 1983, 1994, 1997
Greece	1997	1993-2000	1983-1998	1982-2000
India			1985-1991	1981, 1984-2000
Ireland	1984-1989, 1991-1992	1977, 1979-1995		1976-1989, 1992-1993
Italy	1989-2000	1986-2000	1975-1996	1975-1998
Japan	1999-2000	1997-2000	1977-1985, 1997-2000	1977-1987, 1994-2000
Malaysia		1987-1989 1987-1989	1977, 1983-1984, 1988	1975-1979, 1982-1988
Malta			1998	1992, 1998-2000
Mexico			1982-1987	1975, 1981-1988
Morocco	1989-1991	1984-1986, 1988-1991, 1993-2000	1977-1983, 1986-1987	1977-1989
Netherlands	1985-1998	1974-2000	1983-1984	1977, 1980-1986
Norway		1978-1981, 1994-1995	1977-1979	1977-1979, 1987, 1994

Table 2.3: Bad Times *(continued)*

	(1) $D1(.90)$	(2) $D1(.80)$	(3) $D2(.06)$	(4) $D2(.04)$
Pakistan			1977-1980, 1985-1990, 1993-2000	1975-2000
Panama		1989-1990	1975-1977, 1980, 1983-1985	1975-1985
Paraguay				
Philippines				1983
Portugal			1977, 1982-1992, 1995	1977-1979, 1982-1992, 1995-1996
South Africa			1994-1995	1977-1979, 1985, 1993-1995
Spain			1984-1986	1983-1988, 1995-1997
Sri Lanka		1990	1977, 1980-1992, 1995-1997, 2000	1977-2000
Sweden	1982-1989, 1993-2000	1979-2000	1980-1986, 1994-1995	1979-1987, 1993-1995
Thailand				2000
Tunisia				1976-1978, 1982-1986
Turkey			1998-2000	1986, 1994, 1997-2000
United Kingdom		1974-1978	1976-1978, 1982, 1994	1975-1982, 1986, 1994
United States			1985-1987, 1993	1977, 1982-1994
Uruguay				1984-1985
Venezuela				1996
No. bad times	103	208	215	382

In the first definition of bad times, $D1$, a given country-year t belongs to the bad time regime if the sum of the "cyclically adjusted" government debt at time $t-1$ and the PDV of future government expenditure as a share of potential output is greater than a certain cutoff value x. In column (1) the cutoff value is given by ninetieth percentile of the distribution ($D1(.90)$) and in column (2) it is given by the eightieth percentile ($D1(.80)$). In the second definition of bad times, $D2$, a given country-year t belongs to the bad time regime if the "cyclically adjusted" deficit as a ratio of potential output exceeds a certain value x in the two previous years $t-1$ and $t-2$. In column (3) the threshold is 6% ($D2(.06)$) and in column (4) it is 4% ($D1(.04)$). See section 2.5 for a detailed discussion of the definitions of bad times.

Table 2.4: Estimates All Countries

Var.	Coeff.	(1)	(2)	Coeff.	(3)	(4)
$\hat{\epsilon}_t^G$	γ_1	0.713	0.730	γ_1^u	0.136	0.127
		(0.208)***	(0.221)***		(0.206)	(0.222)
$D_t{*}\hat{\epsilon}_t^G$	$\tilde{\gamma}_1$	-0.081	-0.128	$\tilde{\gamma}_1^u$	0.150	0.121
		(0.417)	(0.378)		(0.375)	(0.293)
$\hat{\epsilon}_t^T$	γ_2	-0.149	-0.165	γ_2^u	-0.106	-0.116
		(0.105)	(0.108)		(0.102)	(0.104)
$D_t{*}\hat{\epsilon}_t^T$	$\tilde{\gamma}_2$	0.037	0.125	$\tilde{\gamma}_2^u$	0.023	0.069
		(0.147)	(0.157)		(0.128)	(0.155)
$\Delta\hat{Y}_{t/t-1}$	μ	0.445	0.447			
		(0.051)***	(0.052)***			
$\Delta\hat{Y}_{t/t}$				μ	0.496	0.494
					(0.052)***	(0.052)***
Sample		All	All		All	All
No. obser.		1080	1080		1080	1080
No. countries		40	40		40	40
R_c^2 first stage		0.164	0.164		0.477	0.478
Def. bad times		$D1_t(.80)$	$D2_t(.06)$		$D1_t(.80)$	$D2_t(.06)$
No. bad times		208	215		208	215

Dependent variable change in real, per capita private consumption, scaled by previous year real per capita disposable income. All regressions include year and country dummies to account for any time and country specific effects. Columns (1) and (2) display estimates of equation (2.1). Columns (3) and (4) display estimates of equation (2.2). In columns (1) and (3) bad time dummy variable is $D1_t(.80)$. In columns (2) and (4) bad time dummy variable is $D2_t(.06)$. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2.5: Estimates Industrial Countries

Var.	Coeff.	(1)	(2)	Coeff.	(3)	(4)
$\hat{\epsilon}_t^G$	γ_1	0.587	0.621	γ_1^u	0.321	0.424
		(0.195)***	(0.231)***		(0.177)*	(0.204)**
$D_t{*}\hat{\epsilon}_t^G$	$\tilde{\gamma}_1$	-0.553	-0.411	$\tilde{\gamma}_1^u$	-0.355	-0.508
		(0.328)*	(0.300)		(0.270)	(0.260)*
$\hat{\epsilon}_t^T$	γ_2	-0.037	0.007	γ_2^u	-0.034	0.001
		(0.061)	(0.074)		(0.057)	(0.068)
$D_t{*}\hat{\epsilon}_t^T$	$\tilde{\gamma}_2$	0.082	-0.070	$\tilde{\gamma}_2^u$	0.064	-0.055
		(0.122)	(0.107)		(0.114)	(0.106)
$\Delta\hat{Y}_{t/t-1}$	μ	0.336	0.342			
		(0.060)***	(0.060)***			
$\Delta\hat{Y}_{t/t}$					0.360	0.368
				μ	(0.037)***	(0.038)***
Sample		Indust	Indust		Indust	Indust
No. obser.		513	513		513	513
No. countries		19	19		19	19
R_c^2 first stage		0.257	0.256		0.561	0.563
Def. bad times		$D1_t(.80)$	$D2_t(.06)$		$D1_t(.80)$	$D2_t(.06)$
No. bad times		97	138		97	138

Dependent variable change in real, per capita private consumption, scaled by previous year real per capita disposable income. All regressions include year and country dummies to account for any time and country specific effects. Columns (1) and (2) display estimates of equation (2.1). Columns (3) and (4) display estimates of equation (2.2). In columns (1) and (3) bad time dummy variable is $D1_t(.80)$. In columns (2) and (4) bad time dummy variable is $D2_t(.06)$. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2.6: Estimates Developing Countries

Var.	Coeff.	(1)	(2)	Coeff.	(3)	(4)
$\hat{\epsilon}_t^G$	γ_1	0.867	0.801	γ_1^u	0.227	0.108
		(0.265)***	(0.257)***		(0.264)	(0.268)
$D_t{*}\hat{\epsilon}_t^G$	$\tilde{\gamma}_1$	-0.283	0.077	$\tilde{\gamma}_1^u$	-0.247	0.416
		(0.472)	(0.486)		(0.482)	(0.364)
$\hat{\epsilon}_t^T$	γ_2	-0.296	-0.290	γ_2^u	-0.165	-0.179
		(0.141)**	(0.142)**		(0.141)	(0.141)
$D_t{*}\hat{\epsilon}_t^T$	$\tilde{\gamma}_2$	0.140	0.114	$\tilde{\gamma}_2^u$	-0.139	0.084
		(0.407)	(0.374)		(0.406)	(0.378)
$\Delta\hat{Y}_{t/t-1}$	μ	0.465	0.465			
		(0.063)***	(0.063)***			
$\Delta\hat{Y}_{t/t}$				μ	0.513	0.513
					(0.064)***	(0.064)***
Sample		Dev	Dev		Dev	Dev
No. obser.		567	567		567	567
No. countries		21	21		21	21
R_c^2 first stage		0.199	0.199		0.501	0.500
Def. bad times		$D1_t(.80)$	$D2_t(.06)$		$D1_t(.80)$	$D2_t(.06)$
No. bad times		107	77		107	77

Dependent variable change in real, per capita private consumption, scaled by previous year real per capita disposable income. All regressions include year and country dummies to account for any time and country specific effects. Columns (1) and (2) display estimates of equation (2.1). Columns (3) and (4) display estimates of equation (2.2). In columns (1) and (3) bad time dummy variable is $D1_t(.80)$. In columns (2) and (4) bad time dummy variable is $D2_t(.06)$. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2.7: Alternative Threshold Values for Bad Times for All Countries

Var.	Coeff.	(1)	(2)	(3)	(4)	(5)	(6)
$\hat{\epsilon}_t^G$	γ_1	0.713	0.728	0.674	0.730	0.788	0.758
		(0.208)***	(0.198)***	(0.221)***	(0.221)***	(0.208)***	(0.241)***
$D_t * \hat{\epsilon}_t^G$	$\tilde{\gamma}_1$	-0.081	-0.759	0.213	-0.128	-0.937	-0.180
		(0.417)	(0.362)**	(0.371)	(0.378)	(0.300)***	(0.355)
$\hat{\epsilon}_t^T$	γ_2	-0.149	-0.151	-0.156	-0.165	-0.156	-0.204
		(0.105)	(0.097)	(0.115)	(0.108)	(0.103)	(0.118)*
$D_t * \hat{\epsilon}_t^T$	$\tilde{\gamma}_2$	0.037	0.101	0.065	0.125	0.080	0.221
		(0.147)	(0.153)	(0.149)	(0.157)	(0.162)	(0.156)
$\Delta \hat{Y}_{t/t-1}$	μ	0.445	0.446	0.447	0.447	0.447	0.449
		(0.051)***	(0.051)***	(0.051)***	(0.052)***	(0.051)***	(0.051)***
Sample		All	All	All	All	All	All
No. obser.		1080	1080	1080	1080	1080	1080
No. countries		40	40	40	40	40	40
R_c^2 first stage		0.164	0.165	0.164	0.164	0.168	0.166
Def. bad times		$D1_t(.80)$	$D1_t(.90)$	$D1_t(.70)$	$D2_t(.06)$	$D2_t(.08)$	$D2_t(.04)$
No. bad times		208	103	312	215	111	382

Dependent variable change in real, per capita private consumption, scaled by previous year real per capita disposable income. All regressions include year and country dummies to account for any time and country specific effects. Columns (1) to (6) display estimates of equation (2.1). In columns (1), (2) and (3) bad time dummy variables are $D1_t(.80)$, $D1_t(.90)$, and $D1_t(.70)$ respectively. In columns (4), (5) and (6) bad time dummy variables are $D2_t(.06)$, $D2_t(.08)$, and $D2_t(.04)$ respectively. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2.8: Alternative Threshold Values for Bad Times for Industrial Countries

Var.	Coeff.	(1)	(2)	(3)	(4)	(5)	(6)
$\hat{\epsilon}_t^G$	γ_1	0.587	0.524	0.658	0.621	0.578	0.615
		(0.195)***	(0.181)***	(0.220)***	(0.231)***	(0.210)***	(0.261)**
$D_t{*}\hat{\epsilon}_t^G$	$\tilde{\gamma}_1$	-0.553	-0.608	-0.559	-0.411	-0.440	-0.316
		(0.328)*	(0.320)*	(0.298)*	(0.300)	(0.316)	(0.325)
$\hat{\epsilon}_t^T$	γ_2	-0.037	-0.019	-0.029	0.007	0.011	-0.038
		(0.061)	(0.059)	(0.070)	(0.074)	(0.067)	(0.080)
$D_t{*}\hat{\epsilon}_t^T$	$\tilde{\gamma}_2$	0.082	-0.013	0.021	-0.070	-0.106	0.043
		(0.122)	(0.121)	(0.100)	(0.107)	(0.110)	(0.108)
$\Delta\hat{Y}_{t/t-1}$	μ	0.336	0.335	0.341	0.342	0.337	0.339
		(0.060)***	(0.060)***	(0.060)***	(0.060)***	(0.059)***	(0.060)***
Sample		Indust	Indust	Indust	Indust	Indust	Indust
No. obser.		513	513	513	513	513	513
No. countries		19	19	19	19	19	19
R_c^2 first stage		0.257	0.254	0.258	0.256	0.257	0.254
Def. bad times		$D1_t(.80)$	$D1_t(.90)$	$D1_t(.70)$	$D2_t(.06)$	$D2_t(.08)$	$D2_t(.04)$
No. bad times		97	48	145	138	82	227

Dependent variable change in real, per capita private consumption, scaled by previous year real per capita disposable income. All regressions include year and country dummies to account for any time and country specific effects. Columns (1) to (6) display estimates of equation (2.1). In columns (1), (2) and (3) bad time dummy variables are $D1_t(.80)$, $D1_t(.90)$, and $D1_t(.70)$ respectively. In columns (4), (5) and (6) bad time dummy variables are $D2_t(.06)$, $D2_t(.08)$, and $D2_t(.04)$ respectively. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2.9: Alternative Threshold Values for Bad Times for Developing Countries

Var.	Coeff.	(1)	(2)	(3)	(4)	(5)	(6)
$\hat{\epsilon}_t^G$	γ_1	0.867	0.727	0.976	0.801	0.882	0.830
		(0.265)***	(0.246)***	(0.301)***	(0.257)***	(0.243)***	(0.280)***
$D_t{*}\hat{\epsilon}_t^G$	$\tilde{\gamma}_1$	-0.283	0.953	-0.510	0.077	-1.065	-0.063
		(0.472)	(0.585)	(0.402)	(0.486)	(0.432)**	(0.435)
$\hat{\epsilon}_t^T$	γ_2	-0.296	-0.265	-0.369	-0.290	-0.290	-0.313
		(0.141)**	(0.140)*	(0.150)**	(0.142)**	(0.137)**	(0.148)**
$D_t{*}\hat{\epsilon}_t^T$	$\tilde{\gamma}_2$	0.140	-0.265	0.374	0.114	0.034	0.208
		(0.407)	(0.482)	(0.276)	(0.374)	(0.487)	(0.292)
$\Delta\hat{Y}_{t/t-1}$	μ	0.465	0.469	0.466	0.465	0.467	0.467
		(0.063)***	(0.061)***	(0.063)***	(0.063)***	(0.062)***	(0.062)***
Sample		Develop	Develop	Develop	Develop	Develop	Develop
No. obser.		567	567	567	567	567	567
No. countries		21	21	21	21	21	21
R_c^2 first stage		0.199	0.203	0.205	0.199	0.203	0.199
Def. bad times		$D1_t(.80)$	$D1_t(.90)$	$D1_t(.70)$	$D2_t(.06)$	$D2_t(.08)$	$D2_t(.04)$
No. bad times		107	52	161	77	29	155

Dependent variable change in real, per capita private consumption, scaled by previous year real per capita disposable income. All regressions include year and country dummies to account for any time and country specific effects. Columns (1) to (6) display estimates of equation (2.1). In columns (1), (2) and (3) bad time dummy variables are $D1_t(.80)$, $D1_t(.90)$, and $D1_t(.70)$ respectively. In columns (4), (5) and (6) bad time dummy variables are $D2_t(.06)$, $D2_t(.08)$, and $D2_t(.04)$ respectively. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2.10: Alternative Definitions for Bad Times for All Countries

Var.	Coeff.	(1)	(2)	(3)	(4)	Coeff.	(5)	(6)	(7)	(8)
$\hat{\epsilon}_t^G$	γ_1	0.713	0.715	0.730	0.789	γ_1^u	0.136	0.128	0.127	0.198
		(0.208)***	(0.204)***	(0.221)***	(0.214)***		(0.206)	(0.204)	(0.222)	(0.206)
$D_t{*}\hat{\epsilon}_t^G$	$\tilde{\gamma}_1$	-0.081	-0.190	-0.128	-0.435	$\tilde{\gamma}_1^u$	0.150	0.280	0.121	-0.243
		(0.417)	(0.346)	(0.378)	(0.439)		(0.375)	(0.329)	(0.293)	(0.345)
$\hat{\epsilon}_t^T$	γ_2	-0.149	-0.132	-0.165	-0.178	γ_2^u	-0.106	-0.094	-0.116	-0.135
		(0.105)	(0.097)	(0.108)	(0.104)*		(0.102)	(0.094)	(0.104)	(0.098)
$D_t{*}\hat{\epsilon}_t^T$	$\tilde{\gamma}_2$	0.037	-0.167	0.125	0.196	$\tilde{\gamma}_2^u$	0.023	-0.146	0.069	0.178
		(0.147)	(0.226)	(0.157)	(0.182)		(0.128)	(0.181)	(0.155)	(0.178)
$\Delta\hat{Y}_{t/t-1}$	μ	0.445	0.447	0.447	0.449					
		(0.051)***	(0.052)***	(0.052)***	(0.052)***					
$\Delta\hat{Y}_{t/t}$						μ	0.496	0.497	0.494	0.495
							(0.052)***	(0.053)***	(0.052)***	(0.052)***
Sample		All	All	All	All		All	All	All	All
No. obser.		1080	1080	1080	1080		1080	1080	1080	1080
No. countries		40	40	40	40		40	40	40	40
R_c^2 first stage		0.164	0.164	0.164	0.166		0.477	0.477	0.478	0.478
Def. bad times		$D1_t(.80)$	$D3_t(.80)$	$D2_t(.06)$	$D4_t(.06)$		$D1_t(.80)$	$D3_t(.80)$	$D2_t(.06)$	$D4_t(.06)$
No. bad times		208	104	215	181		208	104	215	181

Dependent variable change in real, per capita private consumption, scaled by previous year real per capita disposable income. All regressions include year and country dummies to account for any time and country specific effects. Columns (1) to (4) display estimates of equation (2.1). Columns (5) to (8) display estimates of equation (2.2). In columns (1) and (5) bad time dummy variable is $D1_t(.80)$. In columns (2) and (6) bad time dummy variable is $D3_t(.80)$. In columns (3) and (7) bad time dummy variable is $D2_t(.06)$. In columns (4) and (8) bad time dummy variable is $D4_t(.06)$. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2.11: Alternative Definitions for Bad Times for Industrial Countries

Var.	Coeff.	(1)	(2)	(3)	(4)	Coeff.	(5)	(6)	(7)	(8)
$\hat{\epsilon}_t^G$	γ_1	0.587	0.526	0.621	0.599	γ_1^u	0.321	0.299	0.424	0.387
		(0.195)***	(0.191)***	(0.231)***	(0.213)***		(0.177)*	(0.170)*	(0.204)**	(0.191)**
$D_t{*}\hat{\epsilon}_t^G$	$\tilde{\gamma}_1$	-0.553	-0.372	-0.411	-0.435	$\tilde{\gamma}_1^u$	-0.355	-0.369	-0.508	-0.499
		(0.328)*	(0.289)	(0.300)	(0.318)		(0.270)	(0.243)	(0.260)*	(0.277)*
$\hat{\epsilon}_t^T$	γ_2	-0.037	-0.027	0.007	-0.001	γ_2^u	-0.034	-0.025	0.001	-0.014
		(0.061)	(0.058)	(0.074)	(0.068)		(0.057)	(0.054)	(0.068)	(0.062)
$D_t{*}\hat{\epsilon}_t^T$	$\tilde{\gamma}_2$	0.082	0.072	-0.070	-0.057	$\tilde{\gamma}_2^u$	0.064	0.044	-0.055	-0.020
		(0.122)	(0.113)	(0.107)	(0.111)		(0.114)	(0.111)	(0.106)	(0.111)
$\Delta\hat{Y}_{t/t-1}$	μ	0.336	0.337	0.342	0.341					
		(0.060)***	(0.059)***	(0.060)***	(0.059)***					
$\Delta\hat{Y}_{t/t}$						μ	0.360	0.363	0.368	0.368
							(0.037)***	(0.037)***	(0.038)***	(0.038)***
Sample		Indust	Indust	Indust	Indust		Indust	Indust	Indust	Indust
No. obser.		513	513	513	513		513	513	513	513
No. countries		19	19	19	19		19	19	19	19
R_c^2 first stage		0.257	0.253	0.256	0.256		0.561	0.562	0.563	0.562
Def. bad times		$D1_t(.80)$	$D3_t(.80)$	$D2_t(.06)$	$D4_t(.06)$		$D1_t(.80)$	$D3_t(.80)$	$D2_t(.06)$	$D4_t(.06)$
No. bad times		97	67	138	100		97	67	138	100

Dependent variable change in real, per capita private consumption, scaled by previous year real per capita disposable income. All regressions include year and country dummies to account for any time and country specific effects. Columns (1) to (4) display estimates of equation (2.1). Columns (5) to (8) display estimates of equation (2.2). In columns (1) and (5) bad time dummy variable is $D1_t(.80)$. In columns (2) and (6) bad time dummy variable is $D3_t(.80)$. In columns (3) and (7) bad time dummy variable is $D2_t(.06)$. In columns (4) and (8) bad time dummy variable is $D4_t(.06)$. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2.12: Alternative Definitions for Bad Times for Developing Countries

Var.	Coeff.	(1)	(2)	Coeff.	(3)	(4)
$\hat{\epsilon}_t^G$	γ_1	0.867	0.811	γ_1^u	0.227	0.134
		(0.265)***	(0.240)***		(0.264)	(0.251)
$D_t{*}\hat{\epsilon}_t^G$	$\tilde{\gamma}_1$	-0.283	-0.032	$\tilde{\gamma}_1^u$	-0.247	0.592
		(0.472)	(0.495)		(0.482)	(0.462)
$\hat{\epsilon}_t^T$	γ_2	-0.296	-0.258	γ_2^u	-0.165	-0.153
		(0.141)**	(0.139)*		(0.141)	(0.139)
$D_t{*}\hat{\epsilon}_t^T$	$\tilde{\gamma}_2$	0.140	-0.557	$\tilde{\gamma}_2^u$	-0.139	-0.452
		(0.407)	(0.407)		(0.406)	(0.311)
$\Delta\hat{Y}_{t/t-1}$	μ	0.465	0.471			
		(0.063)***	(0.063)***			
$\Delta\hat{Y}_{t/t}$				μ	0.513	0.522
					(0.064)***	(0.065)***
Sample		Dev	Dev		Dev	Dev
No. obser.		567	567		567	567
No. countries		21	21		21	21
R_c^2 first stage		0.199	0.200		0.501	0.499
Def. bad times		$D1_t(.80)$	$D3_t(.80)$		$D1_t(.80)$	$D3_t(.80)$
No. bad times		107	37		107	37

Dependent variable change in real, per capita private consumption, scaled by previous year real per capita disposable income. All regressions include year and country dummies to account for any time and country specific effects. Columns (1) and (2) display estimates of equation (2.1). Columns (3) and (4) display estimates of equation (2.2). In columns (1) and (3) bad time dummy variable is $D1_t(.80)$. In columns (2) and (4) bad time dummy variable is $D3_t(.80)$. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Chapter 3

Debt and Economic Growth in Developing and Industrial Countries

3.1 Introduction

The recent default of Argentina on part of its public debt is the most important default in history. The reason is that the restructuring process involved more than USD 100 billion in government bonds and a wide number of small private bondholders of different nationalities. It was clear that a certain reduction of the public debt would be necessary in order to make the debt situation sustainable. Furthermore, the argentine government did put emphasis that the specific debt reduction should be large enough so that long run economic growth is not affected by the new debt situation. However, although the relationship between public debt and economic growth is a major concern for policymakers, and public opinion in general, there is little empirical work investigating this relationship. Furthermore, there is even less evidence on the specific channels through which debt affects growth.

A recent exception to this lack of empirical evidence is the work by Patillo et al. (2002) and Patillo et al. (2004), which empirically studies the relationship between total external debt and the growth rate of GDP for developing countries. It should be noted that these studies consider total external debt, but does not distinguish between public external debt and private external debt. They conclude that there is a nonlinear relationship, in the form of an inverted-U shape relationship, between total external debt and growth in developing countries. At low levels of total external debt, it affects positively growth, but this relationship becomes negative at high levels of it. The specific turning points are 35-40 percent for the debt-to-GDP ratio and 160-170 percent for the debt-to-exports ratio.

Their paper also presents a short survey of the theoretical and empirical literature dealing with debt and growth. Further, Patillo et al. (2004) suggest that the channels through which total external debt affects economic growth are total factor productivity and capital accumulation. Other previous empirical studies on the nonlinear effects of debt on growth include Smyth and Hsing (1995), Cohen (1997) and Elbadawi (1997).

This paper aims to shed light on these issues by readdressing the relationship between debt and growth in both developing and industrial countries, and exploring the channels through which it may manifest itself. The paper provides a comprehensive treatment of this issue by exploring four different dependent variables (GDP per capita growth rate, total factor productivity growth rate, capital accumulation growth rate, and private savings rate). Further, the debt variables include debt ratios not commonly used (such as debt to years of government revenues) as well as a distinction between public and private external debt for developing countries. Further, it investigates the relationship between gross government debt and economic growth for industrial countries. Note that we will estimate these relationships separately for the sample of developing and industrial countries due to different debt variable definitions. The inclusion of industrial countries, the splitting up of total external debt into public external debt and private external debt, a different and more comprehensive set of explanatory variables, and a longer time span for the data, are the main differences between this paper and Patillo et al. (2002) and Patillo et al. (2004).

In order to uncover these relationships, we use the system GMM dynamic panel econometric technique proposed by Arellano and Bover (1995) and Blundell and Bond (1998). Previous applied growth studies that use this econometric methodology include among others Beck et al. (2000), Levine et al. (2000), Patillo et al. (2002), and Patillo et al. (2004). The data set consist of a panel of 59 developing countries and 24 industrial countries with data averaged over each of the seven 5-year periods between 1970 and 2002. There are several sources of the data, but our main source is the World Development Indicators 2004 of the World Bank.

The rest of the paper is organized in six sections. The empirical methodology and the data used are discussed in sections 3.2 and 3.3 respectively. Section 3.4 presents the estimation results for the different dependent variables and debt indicators for the sample of developing countries. Further, we also presents the results of considering nonlinear effects on GDP growth. In section 3.5 we present the results for the industrial countries. In section 3.6, we discuss and present the results from some consistency test that were made in order to confirm the results from the benchmark case. Finally, section 3.7 concludes.

3.2 Econometric Methodology

The basic regression equation that we use in order to uncover the relationship between debt and economic growth is of the type

$$Y_{i,t} = \alpha X_{i,t} + \gamma D_{i,t} + \eta_i + \lambda_t + \varepsilon_{i,t} \tag{3.1}$$

where $Y_{i,t}$ is the dependent variable, $X_{i,t}$ represents the set of explanatory variables, $D_{i,t}$ is the debt variable, η_i is an unobserved country-specific effect, λ_t is an unobserved time-specific effect, $\varepsilon_{i,t}$ is the error term, and the subscripts i and t represent country and time period, respectively.

When estimating equation (3.1), we use four different dependent variables, namely the growth rate of GDP per capita, the TFP growth rate, the capital accumulation growth rate per capita, and the private savings rate. The reason for estimating equation (3.1) for each of these four dependent variables is that we not only want to study the relationship between debt and growth, but also the relation of debt and the determinants of growth. Regarding $X_{i,t}$, we will use five alternative explanatory variable sets. The first set, which is the base set, includes initial income per capita[1], and educational attainment. The second set adds to the base set government size, openness to trade and inflation. The third set is like the second set, but also includes the level of financial intermediary development. The fourth set is equal to the first set plus population growth and the level of investment. The fifth set adds to the fourth set openness to trade, terms of trade growth and fiscal balance. Note that the second and third set are very similar between each other. The same is valid between the fourth set and the fifth set. In addition, when estimating equation (3.1) for the growth determinants, $X_{i,t}$ includes the lagged dependent variable, which makes the regressions become dynamic in nature. The sources and definitions of these variables are defined more thoroughly in section 3.3. Further, when using the private savings rate as dependent variable (the saving regression), we will use a completely different explanatory variable set. The variables that are used are presented in section 3.3.

Evidently, equation (3.1) is linear in nature. However, we are also interested in investigating if there is any nonlinear relationship between debt and economic growth. Specifically, we are interested in determining whether there exists an inverted-U shape relationship between debt and growth, i.e. low levels of debt are associated with a positive relationship with growth, and high levels of debt are associated with negative growth rates.[2] Therefore, in order to allow for nonlinear effects of debt, we included a linear spline function in equation (3.1). In this case, equation (3.1) becomes

[1] The inclusion of initial income per capita when the dependent variable is the real growth rate of GDP per capita makes equation (3.1) become dynamic in nature. See for example Durlauf et al. (2004).

[2] It has been claimed by Patillo et al. (2002) and Patillo et al. (2004) that such a nonlinear relationship is present.

$$Y_{i,t} = \alpha X_{i,t} + \gamma D_{i,t} + \delta d_{i,t}(D_{i,t} - D^*) + \eta_i + \lambda_t + \varepsilon_{i,t} \quad (3.2)$$

where $d_{i,t}$ is a dummy variable which equals 1 if the value of the debt variable is above a certain threshold value D^* and 0 otherwise. If δ is significantly different from zero, we can conclude that there is a nonlinear relationship. In this case, the impact of debt will be different above and below the threshold D^*, i.e. there will be a structural break. However, in order for there to be an inverted-U shape relationship, γ should be positive and δ should be negative. Further, δ should be larger than γ in absolute terms. The specific threshold values for D^* will depend on the specific debt indicator that is used. However, as there is no theoretical nor empirical indication on any specific threshold value, we chose to estimate equation (3.2) for each debt indicator with nine ad-hoc chosen threshold values. In subsection 3.A1 of the appendix we display the specific threshold values for each debt indicator. In addition, equation (3.2) was estimated for each threshold value with the five alternative explanatory variable sets.

Methodologically, the paper uses the GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998), called dynamic system GMM panel estimator.[3] Further, we use the robust one-step estimates of the standard errors, which are consistent in the presence of any pattern of heteroskedasticity and autocorrelation within panels.[4] There are two conditions that are necessary for the GMM estimator to be consistent, namely that the error term, ε, does not exhibit serial correlation and the validity of the instruments that are used. We use two tests proposed by Arellano and Bond (1991) to validate these assumptions. The first test examines the assumption that the error term is not serially correlated. As this test uses the differenced error term, by construction AR(1) is expected to be present. Therefore, the Arellano-Bond test for autocorrelation determines whether the differenced error term has second-order, or higher, serial correlation. Under the null hypothesis of no second-order serial correlation, the test has a standard-normal distribution. The second assumption is corroborated by a test of over-identifying restrictions, which tests the overall validity of the instruments. Specifically, we use the Hansen J statistic, which is the minimized value of the two-step GMM criterion function. Under the null hypothesis of the validity of the instruments, this test has a χ^2 distribution with $(J-K)$ degrees of freedom, where J is the number of instruments and K the number of regressors. The reason for using this statistic, as opposed to the Sargan statistic, is that it

[3] See Bond (2002) for an introduction to the use of GMM dynamic panel data estimators.

[4] The two-step estimates of the standard errors is asymptotically more efficient than the one-step variant. However, in a finite sample the two-step estimates of the standard errors tend to be severely downward biased (Arellano and Bond, 1991; Blundell and Bond, 1998). Windmeijer (2000) derives a finite-sample correction to the two-step covariance matrix, which can make the two-step variant more efficient than one-step variant. We are, however, unable to implement the Windmeijer finite-sample correction because we have a limited number of cross sections (countries).

is robust to heteroskedasticity and autocorrelation.

There are several reasons for using cross-section time-series data. First, adding the time-series dimension to the data augments the number of observations and the variability of the data. This is especially important for us given that we have a limited number of industrial and developing countries. Second, we are able to control for unobserved country specific effects and thereby reduce biases in the estimated coefficient estimates. Third, the GMM estimator controls for the potential endogeneity of all explanatory variables.[5] This is because the estimator controls for endogeneity by using "internal instruments", i.e. instruments based on lagged values of the explanatory variables. Note that it controls for "weak" endogeneity and not for full endogeneity (Bond, 2002).

3.3 Data

The data set consists of a panel of 59 developing countries and 24 industrial countries, with data averaged over each of the seven 5-year periods between 1970 and 2002 (1970-74; 1975-80; etc.).[6][7] All the variables that we use are averaged data over non-overlapping 5-year periods, as we want to capture the long run relationship between growth and debt, and not be subject to short run cyclical movements. Therefore, the total number of observations for the developing country panel is 413 and for the industrial country panel is 168. However, due to data availability for some samples we had less than these observations, and in most cases we had unbalanced panels. Note that the two country samples, developing and industrial, will be treated separately, due to differences in the debt variable definitions and sources.

The dependent variables are real per capita GDP growth rate (*growth*), total factor productivity growth rate (*prod*), capital stock growth rate per capita (*capgrowth*), and private savings rate (*psr*). For the debt variable, $D_{i,t}$, we use 15

[5] Recall that by including initial income per capita, the growth regression becomes dynamic in nature. Further, the growth determinant regressions include the lagged dependent variable, which also make them dynamic.

[6] Note that for the last period (2000-02), only three observations are available.

[7] The developing countries are Algeria, Argentina, Bangladesh, Bolivia, Brazil, Cameroon, Central African Republic, Chile, China, Colombia, Congo, Dem. Rep., Congo, Rep., Costa Rica, Cote d'Ivoire, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Ethiopia, Gambia, The, Ghana, Guatemala, Guyana, Haiti, Honduras, India, Indonesia, Iran, Islamic Rep., Jamaica, Kenya, Lesotho, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritius, Mexico, Morocco, Mozambique, Myanmar, Nicaragua, Niger, Nigeria, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Rwanda, Senegal, Sierra Leone, South Africa, Sri Lanka, Sudan, Syrian Arab Republic, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Uruguay, Venezuela, RB, Zambia, and Zimbabwe. The industrial countries are Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Korea, Rep., Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States.

different debt indicators for the developing countries: total external debt-to-GDP ratio (*dbtgdp*), total external debt-to-exports ratio (*dbtexp*), total external debt-to-revenues ratio (*dbtrev*), public external debt-to-GDP ratio (*pubdgdp*), public external debt-to-exports ratio (*pubdexp*), public external debt-to-revenues ratio (*pubdrev*), private external debt-to-GDP ratio (*privdgdp*), private external debt-to-exports ratio (*privdexp*), private external debt-to-revenues ratio (*privdrev*), interest payment-to-GDP ratio (*intgdp*), interest payment-to-exports ratio (*intexp*), interest payment-to-revenues ratio (*intrev*), debt service-to-GDP ratio (*dbtsergdp*), debt service-to-exports ratio (*dbtserexp*), and debt service-to-revenues ratio (*dbtserrev*). In the case of the industrial countries, we use 6 different debt indicators: gross government debt-to-GDP ratio (*opubdgdp*), gross government debt-to-exports ratio (*opubdexp*), gross government debt-to-revenues ratio (*opubdrev*), interest payment-to-GDP ratio (*intgdp*), interest payment-to-exports ratio (*intexp*), and interest payment-to-revenues ratio (*intrev*). Note that the main difference between industrial countries and developing countries is that for the former there exist data on total public debt from the OECD Economic Outlook, instead for the later there exists only data for external public debt from the WDI. Further, total external debt, private external debt and debt service data from the WDI is only available for developing countries. Beside the debt variable, the regressors include several variables to control for other factors associated with economic development. Specifically, we have five different explanatory variable sets. The first set consists of the initial income per capita to control for convergence (*linitial*) and average years of schooling as an indicator of the human capital stock in the economy (*lschool*). The second set includes, the variables from the first set, as well as government size (*lgov*) and inflation (*lpi*), which are used as indicators of macroeconomic stability, and openness to trade (*ltrade*) to capture the degree of openness of an economy. The third set adds to the second set a variable for financial intermediary development (*lprivo*). The fourth set includes, apart from initial income and schooling, population growth (*lpop*) and investment to GDP (*linv*). The fifth set includes the variables from the fourth set plus openness to trade (*ltrade*), terms of trade growth (*ltot*), and fiscal balance to GDP ($lfbal$).[8] In addition, the explanatory variable sets for the growth determinant regressions include the lagged dependent variable.

When using the private savings rate as the dependent variable, we will only use one explanatory variable set, which will be different from the ones used for the other regressions. The chosen variables are determined by various theories of consumption, including the classical permanent-income and life-cycle hypothesis and the more recent theories accounting for consumption habits, subsistence consumption, precautionary saving motives, and borrowing constraints. The vari-

[8]Note that the second and third sets are relatively similar to each other. Also, the fourth and fifth sets are related. The variables used in the second and third sets have been used in Beck et al. (2000) and Levine et al. (2000), and the ones in the fourth and fifth sets in Patillo et al. (2002) and Mankiw et al. (1992), among others.

ables are one-period lag of private savings rate (*l.psr*), real per capita Gross Private Disposable Income (*lrpdi*), growth rate of real per capita GPDI (*grpdi*), real interest rate (*lrir*), terms of trade growth (*ltot*), old dependency ratio (*oldr*), young dependency ratio (*yngr*), urbanization ratio (*urbpop*), government savings rate (*gsr*), and inflation (*lpi*).[9]

The source for the data is mainly the World Development Indicators 2004 of the World Bank. However, we also used data from the OECD Economic Outlook, the International Financial Statistics database of the IMF, the Penn World Tables 6.1, the Barro-Lee database on educational attainment, the Financial Development and Structure database of the World Bank, and the Nehru and Dhareshwa Data Set on physical capital stock from the World Bank. Subsection 3.A2 of the appendix presents more detailed information about the sources and definitions of the different variables.

3.4 Estimation results for developing countries

3.4.1 Linear effects on GDP growth

Table 3.1 displays the estimation results of equation (3.1) for developing countries when the dependent variable is the GDP growth rate and the debt indicator is the total external debt-to-GDP ratio. The debt coefficient is negative and significant for all the five different independent variables sets, with the exception of set 2 where it is significant at the 10% level. Specifically, the coefficient values range from -0.864 (column(2)) to -2.146 (column(1)). In the case of the total external debt-to-exports ratio (Table 3.2), the debt coefficients are also negative and significant, with the exception of set 2, with values ranging from -0.791 (column (5)) to -1.969 (column (1)). These results are confirmed when using the total external debt-to-revenues ratio.[10] Thus, for developing countries, there is a significant negative relationship between the level of total external debt and the growth rate of the economy.

In the case of the public external debt-to-GDP ratio, the results are presented in table 3.3. We find a negative relationship with economic growth, with all the coefficients for the different independent variable sets being significant at least at the 5% level and ranging from -0.705 (column(5)) to -1.789 (column(1)). We find similar results in the case of the public external debt-to-exports ratio, with coefficients ranging from -0.639 to -1.983 (table 3.4). Further, these results are corroborated for the public external debt-to-revenues ratio.

When analyzing the results for the private external debt indicators, we find

[9] These variables, with the exception of the lagged private savings rate, are used in the saving regressions of Beck et al. (2000).

[10] These results are not presented due to space considerations, but the tables may be provided upon request from the author.

that the relationship with growth is not significant. In table 3.5, for example, we present the results when using the private external debt-to-GDP variable. Here only the debt coefficient for set 4 (column (4)) is significant. These results are supported for the case of the private external debt-to-exports ratio (table 3.6) and the private external debt-to-revenues ratio. As total external debt is composed of public external debt and private external debt, this suggests that the negative relationship between total external debt and growth is driven by the negative relationship that exists between public external debt, and not by the private component of it. In other words, it seems that high levels of public external debt are associated with low economic growth, but that high levels of private external debt are not necessarily associated with low economic growth.

The results of the linear relationship between GDP growth and the interest payment-to-GDP ratio, interest payment-to-exports ratio, and interest payment-to-revenues ratio are not presented due to space considerations.[11] However, the findings for the interest payment indicators for all five independent variables sets suggest that there is no significant relationship between GDP growth and interest payments. In the case of the debt indicators involving debt services, we have also chosen not to present them to save space. The results for all three debt service ratios, and for all five independent variable sets, show that there is an insignificant association between them and the growth rate of the economy.

3.4.2 Nonlinear effects on GDP growth

In this subsection we present the estimation results for the nonlinear relationship between the debt indicators and economic growth for developing countries using equation 3.2. As noted in section 3.2 nine alternative threshold values were used for each debt indicator. In subsection 3.A1 of the appendix we display the specific threshold values for each debt indicator.

When using the total external debt-to-GDP ratio, we find evidence of nonlinear effects when using a threshold value of 20%. In this case, however, there was no evidence supporting the existence of an inverted-U shape relationship. As can be seen in table 3.7, the debt variable coefficient, $dbtgdp$, is insignificantly different from zero, and the debt dummy variable coefficient, $dbtgdpdum020$, is negative, and significant for all the independent variables sets, i.e. there is no relationship between total external debt and growth when its ratio to GDP is bellow 20%, but there is a negative relationship when its ratio is above 20%. These nonlinear effects dissipated when using the threshold values above 20%. In the case of the total external debt-to-exports ratio, we did not find evidence of nonlinear relationships for any of the nine different threshold values. In table 3.8, we present the results for the total external debt-to-export ratio when using

[11]The tables may be provided upon request from the author.

a threshold value of 150%.[12] We performed the same nonlinear estimation using the total external debt-to-revenues ratio with different threshold values. We find some evidence of nonlinear effects when the total external debt-to-revenues ratio was bellow 150%. In these cases, however, the debt variable coefficient was insignificantly different from zero, while the debt dummy variable coefficient was negative and significant, i.e. there is no evidence of an inverted-U shape relationship. In addition, these nonlinear effects disappeared when estimating equation 3.2 with threshold values above 150%. Concluding, we can assert that there is some evidence of nonlinear effects when using low debt threshold values, but no evidence of an inverted-U shape relationship between total external debt and growth.

It is to be noted that these results are in stark contrast to the results of Patillo et al. (2002), who claim that there is a positive relationship between total external debt and growth when the total external debt-to-GDP ratio is bellow 35-40%, or when the total external debt-to-exports ratio is bellow 160-170%. One possible explanation for this discrepancy is that Patillo et al. (2002) uses only one set of explanatory variables when estimating their growth regressions, which corresponds to our fifth explanatory variable set. As can be seen in table 3.9, when estimating the nonlinear relationship between the total external debt-to-GDP ratio and economic growth with a threshold value of 30%, only the debt dummy coefficient for the fifth explanatory variable set (column (5)) is negative and significant at the 5% level. Therefore, it is possible that their results are driven by the specific selection of explanatory variables.[13]

When considering the public external debt indicators, we did not find any evidence of nonlinear effects for both the ratios to GDP and exports. In the case of the public external debt-to-revenues ratio, we find evidence of nonlinear effects only when using the threshold value 100%. In this case, however, the debt variable coefficient was insignificantly different from zero, while the debt dummy variable coefficient was negative and significant, i.e. the inverted-U shape hypothesis was rejected. For the private external debt indicators, we did not find any evidence of nonlinear effects for the three ratios and all the nine threshold values.

In the cases of the interest payment indicators, we did not find any evidence of nonlinear effects. In the case of the debt service-to-GDP ratio, there is evidence of nonlinear effects and an inverted-U shape relationship with the growth rate when using threshold values bellow 3%. As can be seen in table 3.10, the debt variable coefficient, $dbtsergdp$, is positive and significant, while the debt dummy variable, $dbtsergdpdum003$, is negative and significant. Further, the debt dummy coefficient is larger in absolute value than the debt variable coefficient, which would be supporting the inverted-U shape relationship. These results are interesting when

[12] We decided to show the results for this specific threshold value because Patillo et al. (2002) claim that bellow this threshold there is a positive relationship with growth, and above there is a negative relationship.

[13] This is a common critique to the whole empirical growth literature (Durlauf et al., 2004).

considering that when the linear relationship between debt service-to-GDP ratio and growth was estimated, we found an insignificant relationship. The nonlinear evidence is, however, not supported by the other two debt service ratios (exports and revenues), where the debt dummy variable coefficients are insignificant in all cases. Therefore, the results for the debt service-to-GDP ratio should be taken with caution.

3.4.3 Linear effects on TFP growth

In table 3.11 we present the results for the estimation of equation (3.1) when using the total factor productivity growth as the dependent variable and the total external debt-to-GDP ratio for developing countries. Further, this relationship has also been estimated using the total external debt-to-exports ratio and the total external debt-to-revenues ratio. Although all the debt variable coefficients are negative, they are not significant when using the total external debt-to-GDP ratio. Further, for the total external debt-to-exports ratio, the debt variable coefficients are not significant, but for the first set, which is negative and significant. However, for the total external debt-to-revenues ratio, the debt coefficients are negative and significant for the first four sets. Therefore, there is very weak evidence on the significance of the negative relationship between total external debt and TFP growth. Thus, it is doubtful that the negative relationship between total external debt and GDP growth is driven by the effect of TFP growth on GDP growth.

In the case of the debt indicators involving the public external debt, we can draw the same conclusions as for the total external debt indicators. All the coefficients of the different specifications are insignificant, but for the third and fourth set when using the public external debt-to-revenues ratio. In the case of the private external debt indicators, the debt coefficients are negative and significant for specification one and four for the private external debt-to-GDP ratio and specifications one to four for the private external debt-to-revenues ratio. Thus, no robust relationship between private external debt and TFP growth is found.

In the case of the interest payment and debt service indicators, none of the coefficients are significant for the different independent variable sets. Thus, no relationship between these indicators and TFP growth is found.

3.4.4 Linear effects on capital growth

In this subsection we analyze the relationship between the different debt indicators and per capita growth rate of the capital stock for developing countries. In table 3.12 we present the results of the estimation of equation (3.1) when using capital growth as the dependent variable and the total external debt-to-GDP ratio as the debt variable. Note again that we have also estimated this relationship using the total external debt-to-exports ratio and the total external debt-to-revenues ratio, but due to space reasons we do not present the results. For both the total external debt-to-GDP ratio and the total external debt-to-exports ratio, we find a significant negative relationship between total external debt and capital stock growth. The coefficients range from -0.672 and -1.000 in the case of the total external debt-to-GDP ratio, and are all significant at the 5% level, but for the fourth set, which is significant at the 10% level. In the case of the total external debt-to-revenues ratio, although we find that all the coefficients are negative, only the second and third sets are significant. These results, in combination with the findings presented in subsection 3.4.3, suggest that the main driving factor behind the negative relationship between total external debt and GDP growth seems to be the influence of external debt on capital stock accumulation.

Regarding the indicators of public external debt, the estimation results for the GDP ratio is presented in table 3.13. Our findings show that there is a significant negative relationship between public external debt and capital accumulation. The negative coefficients are all significant at the 5% level and range from -0.620 to -1.110 in the case of the public external debt-to-GDP ratio. These results are similar to those obtained for the public external debt-to-exports ratio. In the case of the public external debt-to-revenues ratio, we find that the debt variable coefficient is significant for the first three sets. Regarding the private external debt, we do not find any significant relationship between these debt indicators and capital accumulation. Thus, we reach the conclusion that the negative relationship between total external debt and capital accumulation growth is mainly due to the influence of public external debt.

In so far as the interest payment indicators are concerned, there is no evidence on any significant relationship between interest payments and capital accumulation. For the debt service indicators, we find some evidence that it has a significant negative relationship with capital accumulation. For the debt service-to-GDP ratio, the last four sets have a significant debt coefficient. For the debt service-to-exports ratio and the debt service-to-revenues ratio, three of five sets and two of five sets have a significant debt variable coefficient, respectively.

3.4.5 Linear effects on private savings rate

In this subsection we will present the results of the savings regression for developing countries. The results for some of the external debt indicators are presented in table 3.14. The estimated equation is similar to equation (3.1) and we use the same system GMM estimator as before. The difference, however, is that we use a unique and different independent variable set, as explained in section 3.3. In the case of the total external debt indicators, we only find that the debt variable coefficient is significantly different from zero, with a negative value of -0.028, for the total external debt-to-exports ratio. The same results are obtained for the public external debt indicators, where the only significant debt coefficient is for the public external debt-to-exports ratio, with a negative value of -0.024. The significance of these coefficients in both cases is reverted when doing the same estimation with the data set without outliers. Thus, there seems to be no clear relationship between total and public external debt and the private savings rate of an economy. Regarding the private external debt indicators, we find that the debt coefficients for all three ratios are positive. However, they are only significant for the private external debt-to-GDP ratio. Therefore, there is no strong evidence that there is a positive relationship between private external debt and the private savings rate. In the case of the interest payments indicators, as well as for the debt service indicators, we do not find any significant relationship between these ratios and the private savings rate.

3.5 Estimation results for industrial countries

3.5.1 Linear and nonlinear effects on GDP growth

In this subsection we will present the results for industrial countries when estimating equation (3.1) with the GDP growth as the dependent variable. Table 3.15 displays the results for the gross government debt-to-GDP ratio, where it is clear that all the debt coefficients are insignificant, except for the debt coefficient when using the fifth independent variable set. The debt coefficient when using the fifth independent set is positive and significant at the 1% level with a value of 0.355. This specific result would be indicating that there is a positive relationship between gross government debt levels and economic growth. These results are also obtained when using the gross government debt-to-exports ratio and the gross government debt-to-revenues ratio. We conclude therefore that, although we found a positive relationship between the three different debt ratios and economic growth for the fifth independent variable set, the evidence tends to support an insignificant relationship between gross government debt and economic growth for industrial countries.

In the case of the relationship between the interest payment ratios and economic growth for industrial countries, we did not find any evidence supporting a significant relationship between them.

Regarding the possibility of a nonlinear relationship between gross government debt and growth, we did not find any evidence that supported such an hypothesis.

3.5.2 Linear effects on TFP growth

From table 3.16, which shows the results for the gross government debt-to-GDP ratio for industrial countries, it is clear that no relationship between government debt and total factor productivity growth is found. All the debt coefficients for the five different independent variable sets are positive, but insignificant in four out of five sets. Similar results are found for the gross government debt-to-exports ratio and gross government-to-revenues ratio, which are not shown to save space.

When using the interest payment-to-GDP ratio, we find no evidence of any significant relationship between this ratio and TFP growth. The same applies to the other two ratios (interest payment-to-exports ratio and interest payment-to-revenues ratios).

3.5.3 Linear effects on capital growth

The estimation of equation (3.1) when using the capital accumulation growth ratio as the dependent variable and the gross government debt-to-GDP ratio as the debt variable for industrial countries are presented in table 3.17. All the debt coefficients, but for the first set, are insignificantly different from zero. In the case when using the gross government debt-to-exports and the gross government debt-to-revenues ratio, we do not find that any of the debt coefficients are significant. We can therefore assert that there does not seem to be any significant relationship between gross government debt and capital accumulation growth.

In the case of the estimation of equation (3.1) when using the interest payment ratios as the debt variable, we do not find evidence of any relationship between them and capital accumulation growth for any of the three ratios.

3.5.4 Linear effects on private savings rate

In the case of the saving regression for industrial countries, and when using the gross government debt ratios, we find mixed results regarding the significance of the relationship between the debt ratios and private savings rates. In table 3.18 we see that the debt coefficient is insignificant for the gross government debt-to-GDP ratio, but negative and significant for the gross government debt-to-exports ratio and the gross government debt-to-revenues ratio. Thus, we conclude that there is some evidence supporting the negative relationship between the gross government debt level and private savings rates for industrial countries.

Table 3.18 shows also the estimation results when using the interest payment ratios. In this case, only the interest payment-to-exports is significant, and we can therefore conclude that no strong relationship between interest payments level and private savings rates is found.

3.6 Consistency tests

In order to corroborate the results of sections 3.4 and 3.5, we performed two consistency tests. First, all the estimated equations were estimated without outliers. We identified outliers using the method of Hadi (1994). Second, we used 3-year averages, instead of using 5-year averages, which increased the time span to 11 periods and the sample size to 649 observations for developing countries and 264 observations for industrial countries. After performing these consistency tests, we did not obtain results that changed the benchmark case results from sections 3.4 and 3.5. Consequently, the benchmark case results could not be refuted and are robust to both consistency tests.[14]

3.7 Conclusions

This paper has investigated both the linear and nonlinear relationship between debt and economic growth for developing and industrial countries. Further, it has tried to determine the channels through which debt affects economic growth, by considering its effects on total factor productivity, capital accumulation and private savings rates, respectively. In order to specify the growth regression, we have used five alternative independent variables sets commonly used in the empiric growth literature.

The results show that for developing countries there is a negative and significant relationship between total external debt and economic growth, i.e. lower total external debt levels are associated with higher growth rates. Further, when distinguishing between public external debt and private external debt, we find a negative relationship between public external debt and growth, but no significant relationship when only considering private external debt. Therefore, we conclude that the negative relationship between total external debt and economic growth is driven by the incidence of public external debt levels, and not by private external debt levels. Insofar as the channels through which external debt accumulation affects growth are concerned, the results suggest that this is mainly driven by the capital accumulation growth, with only limited evidence on the relationship between external debt and total factor productivity growth. In addition, private savings rates are not affected by external debt levels. Further, we have found very limited evidence of nonlinear effects for these relationships. When considering other debt indicators, such as interest payments and debt services, the results suggest that there is no robust relationship between these debt indicators and growth.

Our results for developing countries are in contrast to the results of Patillo et al. (2002), who find evidence of a nonlinear relationship between total external debt and growth. Moreover, they find that there is a positive relationship between total external debt and economic growth when the external debt level is bellow a certain threshold, and a negative relationship when it is above the threshold, i.e. an inverted-U shape relationship. In contrast, we find that there is only limited support for a nonlinear relationship, and no evidence of a positive relationship between total external debt and growth at low debt levels, i.e. there

[14] The tables may be provided upon request from the author.

is no indication on the existence of an inverted-U shape relationship between external debt and growth.

In the case of industrial countries, we did not find any robust linear and nonlinear relationship between gross government debt and economic growth (nor the growth determinants, with the exception of the private savings rate). This is a very interesting result because it would be suggesting that for industrial countries higher public debt levels are not necessarily associated with lower GDP growth rates. Clearly, this is in stark contrast to the results for developing countries, where the relationship is negative and significant. The question that remains to be answered is what is the reason for the difference between developing and industrial countries.

Although our results lend partial support to the view that public external debt in developing countries may tend to crowd out economic activity by discouraging capital accumulation, it would have been desirable to estimate these relationships with a complete set of public debt data (i.e. including domestic debt and not only external). If data were available for a sufficiently long span of time and large sample of countries, this would be a suitable avenue for further research on this issue.

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Appendix

3.A1 Alternative threshold values for the dummy variables

As explained in section 3.2, we estimated equation 3.2 using alternative threshold values for each debt indicator. Specifically, for the total external debt-to-GDP ratio, the public external debt-to-GDP ratio, and the gross government debt-to-GDP ratio, we estimated the equation with nine alternative threshold values ranging from 20% to 100% with 10% intervals. For the total external debt-to-exports ratio, the public external debt-to-exports ratio, and the gross government debt-to-exports ratio, the threshold values were 50%, 100%, 150%, 200%, 250%, 300%, 350%, 400%, and 500%. For the total external debt-to-revenues ratio, the public external debt-to-revenues ratio, and the gross government debt-to-revenues ratio, the threshold values were 100%, 150%, 200%, 250%, 300%, 350%, 400%, 450%, and 500%. For the interest payment-to-GDP ratio, the threshold values were 0.5%, 1%, 1.5%, 2%, 2.5%, 3%, 4%, 5%, and 6%. For both the interest payment-to-exports ratio and the interest payment-to-revenues ratio, the following threshold values were used: 2%, 5%, 8%, 10%, 12%, 15%, 16%, 20%, 25%. In the case of the debt service-to-GDP ratio, the threshold values 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, and 10% were used. For the debt service-to-exports ratio, the threshold values were 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, and 45%. Finally, for the debt service-to-revenue, we used 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, and 50%.

3.A2 Data sources and definitions

The data was mainly taken from the World Development Indicators 2004 of the World Bank (WDI). However, we also used data from the OECD Economic Outlook, the International Financial Statistics database of the IMF (IFS), the Penn World Tables 6.1 (PWT), the Barro-Lee database on educational attainment, the Financial Development and Structure database of the World Bank, and the Nehru and Dhareshwa Data Set on physical capital stock from the World Bank. All the variables are used in log form, with the exception of the growth rate of GDP, capital accumulation growth, TFP growth, private savings rates, GPDI growth, old dependency ratio, young dependency ratio, urbanization ratio, and government saving rate. Bellow is a list of the sources and definitions of the different variables used in this study.

1. Total external debt (*dbt*): Debt owed to nonresidents repayable in foreign currency, goods, or services. Total external debt is the sum of public, publicly guaranteed, and private nonguaranteed long-term debt, use of IMF credit, and short-term debt. Short-term debt includes all debt having an

original maturity of one year or less and interest in arrears on long-term debt. Source: WDI.

2. Government external debt (*pubd*): Public and publicly guaranteed debt comprises long-term external obligations of public debtors, including the national government, political subdivisions (or an agency of either), and autonomous public bodies, and external obligations of private debtors that are guaranteed for repayment by a public entity. Source: WDI.

3. Private external debt (*prid*): Private nonguaranteed external debt comprises long-term external obligations of private debtors that are not guaranteed for repayment by a public entity. Source: WDI.

4. Gross Government debt (*opubd*): General government gross financial liabilities. Source: OECD Economic Outlook.

5. Interest payment (*int*): Interest payments by central government to domestic sectors and to nonresidents for the use of borrowed money. Source: WDI.

6. Debt service (*dbtser*): Total debt service is the sum of principal repayments and interest actually paid in foreign currency, goods, or services on long-term debt, interest paid on short-term debt, and repayments (repurchases and charges) to the IMF. Source: WDI.

7. GDP (*gdp*): Gross domestic product. Source: WDI.

8. Exports (*exp*): Exports of goods and services. Source: WDI.

9. Revenues (*rev*): Current revenue, excluding grants for central government. Source: WDI.

10. Real per capita GDP growth rate (*growth*): Annual percentage growth rate of GDP per capita based on constant local currency. Source: WDI.

11. Real per capita capital stock growth (*capgrowth*): We estimate the capital stock following the perpetual inventory method with steady-state estimates of initial capital (King and Levine, 1994). The initial steady-state estimates of capital for 1960 are taken from the Nehru and Dhareshwa Data Set on physical capital stock from the World Bank. We used the Gross fixed capital formation series at constant prices from the WDI, and we assumed a depreciation rate of 7%. The capital stock was divided by total population from the WDI. Source: WDI and Nehru and Dhareshwa Data Set.

12. Total factor productivity growth (*prod*): In order to compute the data on TFP, a neoclassical production function with physical capital K, labor L,

the level of total factor productivity A, and the capital share α is used. In addition it is assumed that all the countries have the same Cobb-Douglas type of production function, so that aggregate output for each country i, Y_i, is given by

$$Y_i = A_i K_i^{\alpha} L_i^{1-\alpha}. \tag{3.3}$$

Then, equation (3.3) is divided by L to get per capita production. Secondly, a log transformation is made and the time derivative is taken. Finally, assuming a capital share $\alpha = 0.3$ and solving for the growth rate of productivity, we have

$$prod = growth - 0.3 * capgrowth.$$

where *growth* is the real per capita GDP growth rate and *capgrowth* is real per capita capital stock growth.

13. Initial income per capita (*linitial*): The logarithm of lagged real (PPP) per capita GDP (constant prices). Source: PWT.

14. Average years of schooling (*lschool*): The logarithm of one plus the average years of schooling in the total population over 25. Source: Barro-Lee database.

15. Government size (*lgov*): The logarithm of the ratio of General government final consumption expenditure to GDP. Source: WDI.

16. Inflation (*lpi*): The logarithm of one plus the inflation rate, which is calculated using the average annual consumer price index. Source: WDI.

17. Openness to trade (*ltrade*): The logarithm of the sum of exports of goods and services and imports of goods and services as a share of GDP. Source: WDI.

18. Terms of trade growth (*ltot*): The logarithm of one plus the growth rate of the terms of trade. Source: WDI.

19. Financial intermediary development (*lprivo*): The logarithm of the ratio of Private credit by deposit money banks and other financial institutions to GDP. Source: Financial Development and Structure database.

20. Private savings rate (*psr*): The ratio of Gross private saving and Gross private disposable income (GPDI). Gross private saving is measured as the difference between Gross national savings, including NCTR and Overall budget balance, including grants. GPDI is measured as the difference between Gross national disposable income (GNDI) and Gross public disposable income. GNDI is the sum of Gross national income and Net current

transfers from abroad. Gross public disposable income is the sum of Overall budget balance, including grants and General government final consumption expenditure. A similar method is used in Loayza et al. (1998). Source: WDI and IFS.

21. Real per capita GPDI (*lrpdi*): The log of GPDI divided by total population and multiplied by a PPP index. The PPP index is constructed by dividing real (PPP) per capita GDP (constant prices) and per capita GDP (current LCU). Sources: WDI and PWT.

22. Growth rate of GPDI (*grpdi*): Growth rate of GPDI per capita at constant prices, which equals to GPDI divided by total population and GDP deflator. Source: WDI.

23. Real interest rate (*lrir*): The logarithm of one plus the real interest rate. Source: WDI.

24. Old dependency ratio (*oldr*): The share of population over 65 in total population. Source: WDI.

25. Young dependency ratio (*yngr*): The share of population under 15 in total population. Source: WDI.

26. Urbanization ratio (*urbpop*): The share of population that lives in urban areas. Source: WDI.

27. Government savings rate (*gsr*): The ratio of Overall budget balance, including grants, and GPDI. Source: WDI and IFS.

Table 3.1: Total external debt-to-GDP: Linear effects on GDP growth for developing countries

	(1)	(2)	(3)	(4)	(5)
linitial	-1.782	-0.553	-1.143	-2.092	-1.276
	(0.841)**	(0.670)	(0.577)*	(0.372)***	(0.327)***
lschool	4.399	1.862	2.575	1.258	0.817
	(1.253)***	(1.077)*	(0.777)***	(0.774)	(0.450)*
dbtgdp	-2.146	-0.864	-0.996	-1.202	-0.873
	(0.642)***	(0.471)*	(0.423)**	(0.329)***	(0.314)***
lgov		-1.371	-0.725		
		(0.763)*	(0.622)		
ltrade		1.536	1.408		0.087
		(0.474)***	(0.463)***		(0.373)
lpi		-2.076	-1.531		
		(0.919)**	(0.883)*		
lprivo			0.329		
			(0.127)**		
lpop				-4.877	-4.612
				(3.053)	(2.389)*
linv				5.545	5.568
				(0.668)***	(0.517)***
ltot					4.183
					(1.274)***
lfbal					14.367
					(4.507)***
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.000	0.000	0.000	0.000	0.012
AR(2) test	0.654	0.347	0.343	0.511	0.364
Observations	396	366	345	377	282
No. of countries	59	59	59	59	47

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover, 1995; Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.2: Total external debt-to-exports: Linear effects on GDP growth for developing countries

	(1)	(2)	(3)	(4)	(5)
linitial	-1.974	-0.541	-1.225	-2.213	-1.320
	(0.844)**	(0.720)	(0.651)*	(0.527)***	(0.325)***
lschool	4.043	1.967	2.765	0.906	0.680
	(1.326)***	(1.089)*	(0.815)***	(0.853)	(0.449)
dbtexp	-1.969	-0.627	-0.886	-1.252	-0.791
	(0.585)***	(0.435)	(0.403)**	(0.410)***	(0.277)***
lgov		-1.148	-0.639		
		(0.795)	(0.667)		
ltrade		0.649	0.364		-0.752
		(0.524)	(0.528)		(0.384)*
lpi		-2.229	-1.692		
		(0.910)**	(0.895)*		
lprivo			0.301		
			(0.110)***		
lpop				-6.156	-4.490
				(3.485)*	(2.379)*
linv				5.199	5.659
				(0.779)***	(0.522)***
ltot					4.319
					(1.259)***
lfbal					14.374
					(4.502)***
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.000	0.000	0.000	0.000	0.012
AR(2) test	0.791	0.311	0.338	0.656	0.380
Observations	392	366	345	376	282
No. of countries	59	59	59	59	47

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.3: Public external debt-to-GDP: Linear effects on GDP growth for developing countries

	(1)	(2)	(3)	(4)	(5)
linitial	-1.773	-0.543	-1.154	-2.142	-1.324
	(0.786)**	(0.690)	(0.596)*	(0.323)***	(0.336)***
lschool	4.068	1.734	2.719	1.182	0.615
	(1.144)***	(1.031)*	(0.790)***	(0.754)	(0.480)
pubdgdp	-1.789	-0.868	-0.884	-1.038	-0.705
	(0.572)***	(0.392)**	(0.355)**	(0.286)***	(0.265)**
lgov		-1.362	-0.723		
		(0.758)*	(0.650)		
ltrade		1.432	1.306		-0.031
		(0.457)***	(0.440)***		(0.360)
lpi		-2.054	-1.672		
		(0.906)**	(0.883)*		
lprivo			0.268		
			(0.099)***		
lpop				-4.475	-4.759
				(3.078)	(2.394)*
linv				5.538	5.622
				(0.634)***	(0.525)***
ltot					4.577
					(1.345)***
lfbal					13.911
					(4.414)***
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.000	0.000	0.000	0.000	0.012
AR(2) test	0.534	0.322	0.296	0.475	0.347
Observations	396	366	345	377	282
No. of countries	59	59	59	59	47

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.4: Public external debt-to-exports: Linear effects on GDP growth for developing countries

	(1)	(2)	(3)	(4)	(5)
linitial	-2.342	-0.379	-1.134	-2.392	-1.360
	(0.761)***	(0.726)	(0.678)*	(0.480)***	(0.336)***
lschool	4.006	1.568	2.595	1.255	0.545
	(1.258)***	(1.031)	(0.838)***	(0.868)	(0.495)
pubdexp	-1.983	-0.639	-0.775	-1.084	-0.664
	(0.453)***	(0.365)*	(0.336)**	(0.324)***	(0.237)***
lgov		-1.177	-0.597		
		(0.759)	(0.675)		
ltrade		0.445	0.412		-0.685
		(0.524)	(0.496)		(0.373)*
lpi		-2.230	-1.765		
		(0.878)**	(0.887)*		
lprivo			0.265		
			(0.099)***		
lpop				-5.076	-4.564
				(3.681)	(2.441)*
linv				5.271	5.761
				(0.753)***	(0.535)***
ltot					4.631
					(1.317)***
lfbal					14.361
					(4.416)***
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.000	0.000	0.000	0.000	0.012
AR(2) test	0.700	0.287	0.292	0.597	0.354
Observations	392	366	345	376	282
No. of countries	59	59	59	59	47

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.5: Private external debt-to-GDP: Linear effects on GDP growth for developing countries

	(1)	(2)	(3)	(4)	(5)
linitial	0.308	-0.421	-0.608	-0.615	-0.929
	(0.790)	(0.527)	(0.494)	(0.550)	(0.389)**
lschool	0.890	1.113	0.751	-0.552	-0.284
	(1.116)	(0.884)	(0.716)	(0.791)	(0.618)
pridgdp	-0.355	-0.143	-0.222	-0.424	-0.229
	(0.252)	(0.168)	(0.150)	(0.132)***	(0.133)*
lgov		-1.290	-1.424		
		(0.765)*	(0.577)**		
ltrade		0.710	0.608		-0.210
		(0.495)	(0.382)		(0.385)
lpi		-1.789	-0.844		
		(0.902)*	(0.620)		
lprivo			1.168		
			(0.303)***		
lpop				-5.023	-5.422
				(3.033)	(2.665)**
linv				5.550	5.273
				(0.562)***	(0.540)***
ltot					4.310
					(1.407)***
lfbal					14.901
					(5.008)***
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.001	0.001	0.001	0.000	0.006
AR(2) test	0.315	0.345	0.393	0.380	0.041
Observations	268	261	248	262	224
No. of countries	46	46	46	46	40

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.6: Private external debt-to-exports: Linear effects on GDP growth for developing countries

	(1)	(2)	(3)	(4)	(5)
linitial	0.160	-0.411	-0.630	-0.931	-0.939
	(0.766)	(0.532)	(0.492)	(0.543)*	(0.388)**
lschool	0.911	1.141	0.748	-0.322	-0.286
	(1.130)	(0.882)	(0.719)	(0.795)	(0.621)
pridexp	-0.336	-0.122	-0.215	-0.263	-0.235
	(0.241)	(0.177)	(0.154)	(0.126)**	(0.135)*
lgov		-1.262	-1.431		
		(0.764)	(0.576)**		
ltrade		0.581	0.396		-0.442
		(0.550)	(0.401)		(0.388)
lpi		-1.790	-0.854		
		(0.897)*	(0.620)		
lprivo			1.160		
			(0.303)***		
lpop				-6.049	-5.379
				(3.194)*	(2.677)*
linv				5.238	5.283
				(0.529)***	(0.539)***
ltot					4.313
					(1.411)***
lfbal					14.921
					(5.025)***
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.001	0.001	0.001	0.000	0.006
AR(2) test	0.343	0.340	0.388	0.355	0.042
Observations	267	261	248	262	224
No. of countries	46	46	46	46	40

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.7: Total external debt-to-GDP: Nonlinear effects on GDP growth with a threshold of 20% for developing countries

	(1)	(2)	(3)	(4)	(5)
linitial	-2.068	-1.163	-1.378	-2.213	-1.400
	(0.872)**	(0.606)*	(0.565)**	(0.365)***	(0.350)***
lschool	4.185	2.524	2.557	1.062	0.831
	(1.208)***	(0.934)***	(0.693)***	(0.718)	(0.464)*
dbtgdp	0.856	0.845	0.605	0.321	0.765
	(0.735)	(0.710)	(0.743)	(0.563)	(0.680)
dbtgdpdum020	-2.672	-2.376	-2.096	-1.988	-2.202
	(0.969)***	(0.990)**	(0.970)**	(0.752)**	(0.852)**
lgov		-0.825	-0.489		
		(0.741)	(0.614)		
ltrade		1.232	1.107		0.155
		(0.518)**	(0.443)**		(0.353)
lpi		-1.872	-1.417		
		(0.965)*	(0.880)		
lprivo			0.352		
			(0.122)***		
lpop				-5.654	-4.287
				(2.798)**	(2.279)*
linv				5.265	5.441
				(0.598)***	(0.505)***
ltot					4.102
					(1.248)***
lfbal					12.302
					(4.402)***
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.000	0.000	0.000	0.000	0.011
AR(2) test	0.619	0.327	0.308	0.541	0.467
Observations	396	366	345	377	282
No. of countries	59	59	59	59	47

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.8: Total external debt-to-exports: Nonlinear effects on GDP growth with a threshold of 150% for developing countries

	(1)	(2)	(3)	(4)	(5)
linitial	-1.990	-0.487	-1.255	-2.092	-1.325
	(0.781)**	(0.642)	(0.572)**	(0.500)***	(0.326)***
lschool	3.838	2.206	2.778	0.859	0.730
	(1.042)***	(0.972)**	(0.733)***	(0.798)	(0.457)
dbtexp	-0.465	-0.833	-0.835	-1.135	-0.691
	(0.672)	(0.644)	(0.594)	(0.497)**	(0.549)
dbtexpdum150	-1.467	0.521	-0.002	-0.042	-0.147
	(1.036)	(0.932)	(0.817)	(0.646)	(0.686)
lgov		-0.988	-0.565		
		(0.793)	(0.655)		
ltrade		0.424	0.142		-0.808
		(0.573)	(0.543)		(0.371)**
lpi		-2.380	-1.762		
		(0.932)**	(0.924)*		
lprivo			0.316		
			(0.114)***		
lpop				-6.603	-4.438
				(3.384)*	(2.386)*
linv				4.904	5.647
				(0.668)***	(0.511)***
ltot					4.337
					(1.256)***
lfbal					13.893
					(4.480)***
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.000	0.000	0.000	0.000	0.012
AR(2) test	0.833	0.261	0.333	0.655	0.401
Observations	392	366	345	376	282
No. of countries	59	59	59	59	47

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.9: Total external debt-to-GDP: Nonlinear effects on GDP growth with a threshold of 30% for developing countries

	(1)	(2)	(3)	(4)	(5)
linitial	-1.836	-0.866	-1.355	-2.179	-1.411
	(0.845)**	(0.600)	(0.545)**	(0.383)***	(0.362)***
lschool	3.914	2.219	2.601	1.049	0.898
	(1.051)***	(0.976)**	(0.637)***	(0.757)	(0.464)*
dbtgdp	-0.241	-0.219	-0.289	-0.401	0.136
	(0.686)	(0.672)	(0.651)	(0.497)	(0.517)
dbtgdpdum030	-1.381	-1.145	-1.207	-1.258	-1.653
	(0.922)	(0.980)	(0.954)	(0.744)*	(0.782)**
lgov		-0.794	-0.518		
		(0.714)	(0.610)		
ltrade		1.232	1.183		0.099
		(0.473)**	(0.467)**		(0.348)
lpi		-1.920	-1.380		
		(0.931)**	(0.899)		
lprivo			0.362		
			(0.129)***		
lpop				-5.689	-4.239
				(2.863)*	(2.283)*
linv				5.295	5.493
				(0.571)***	(0.508)***
ltot					4.128
					(1.267)***
lfbal					12.348
					(4.407)***
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.000	0.000	0.000	0.000	0.009
AR(2) test	0.629	0.318	0.316	0.524	0.404
Observations	396	366	345	377	282
No. of countries	59	59	59	59	47

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.10: Debt service payments-to-GDP: Nonlinear effects on GDP growth with a threshold of 3% for developing countries

	(1)	(2)	(3)	(4)	(5)
linitial	-0.244	-0.466	-0.829	-2.013	-1.104
	(0.792)	(0.518)	(0.498)	(0.464)***	(0.339)***
lschool	1.341	1.954	2.488	1.584	0.522
	(0.939)	(0.951)**	(0.782)***	(0.663)**	(0.482)
dbtsergdp	1.503	1.421	1.100	0.454	0.947
	(0.677)**	(0.562)**	(0.546)**	(0.502)	(0.537)*
dbtsergdpdum003	-2.352	-2.301	-2.011	-1.706	-1.685
	(0.956)**	(0.772)***	(0.776)**	(0.761)**	(0.761)**
lgov		-1.023	-0.742		
		(0.698)	(0.611)		
ltrade		0.462	0.549		-0.403
		(0.495)	(0.469)		(0.450)
lpi		-2.666	-2.139		
		(0.720)***	(0.733)***		
lprivo			0.352		
			(0.153)**		
lpop				-4.640	-5.052
				(3.278)	(2.432)**
linv				5.849	5.793
				(0.613)***	(0.558)***
ltot					4.143
					(1.299)***
lfbal					16.482
					(4.411)***
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.000	0.001	0.000	0.000	0.011
AR(2) test	0.356	0.155	0.218	0.627	0.336
Observations	396	366	345	377	282
No. of countries	59	59	59	59	47

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.11: Total external debt-to-GDP: Linear effects on TFP growth for developing countries

	(1)	(2)	(3)	(4)	(5)
l.prod	0.099	0.112	0.101	-0.092	0.003
	(0.071)	(0.074)	(0.077)	(0.069)	(0.076)
linitial	-0.797	-0.672	-0.707	-1.398	-0.808
	(0.538)	(0.504)	(0.403)*	(0.480)***	(0.362)**
lschool	1.058	1.549	1.370	1.205	0.556
	(0.906)	(0.813)*	(0.601)**	(0.847)	(0.511)
dbtgdp	-0.839	-0.140	-0.391	-0.528	-0.153
	(0.451)*	(0.401)	(0.340)	(0.268)*	(0.257)
lgov		-0.716	-0.670		
		(0.563)	(0.453)		
ltrade		0.693	0.434		-0.457
		(0.508)	(0.511)		(0.438)
lpi		-0.748	-0.337		
		(0.650)	(0.538)		
lprivo			0.289		
			(0.086)***		
lpop				-2.223	-3.343
				(3.058)	(2.246)
linv				4.454	4.256
				(0.679)***	(0.677)***
ltot					5.081
					(1.447)***
lfbal					12.087
					(3.446)***
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.000	0.000	0.000	0.001	0.009
AR(2) test	0.821	0.973	0.628	0.339	0.894
Observations	317	300	286	310	259
No. of countries	51	51	51	51	45

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.12: Total external debt-to-GDP: Linear effects on capital growth for developing countries

	(1)	(2)	(3)	(4)	(5)
l.capgrowth	0.632	0.599	0.614	0.574	0.640
	(0.062)***	(0.063)***	(0.061)***	(0.056)***	(0.051)***
linitial	-1.277	-0.817	-0.781	-1.368	-1.149
	(0.586)**	(0.370)**	(0.353)**	(0.359)***	(0.276)***
lschool	1.621	0.594	0.970	-0.080	0.141
	(1.119)	(0.690)	(0.569)*	(0.789)	(0.462)
dbtgdp	-1.000	-0.980	-0.961	-0.672	-0.691
	(0.371)***	(0.364)***	(0.330)***	(0.341)*	(0.333)**
lgov		-1.181	-1.177		
		(0.509)**	(0.493)**		
ltrade		1.034	1.195		0.838
		(0.377)***	(0.345)***		(0.328)**
lpi		-0.328	-0.305		
		(0.389)	(0.366)		
lprivo			-0.013		
			(0.052)		
lpop				-6.935	-5.770
				(2.554)***	(2.100)***
linv				2.991	2.194
				(0.688)***	(0.601)***
ltot					3.578
					(2.313)
lfbal					6.571
					(4.259)
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.008	0.016	0.025	0.013	0.015
AR(2) test	0.306	0.466	0.515	0.320	0.609
Observations	321	302	288	314	261
No. of countries	51	51	51	51	45

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.13: Public external debt-to-GDP: Linear effects on capital growth for developing countries

	(1)	(2)	(3)	(4)	(5)
l.capgrowth	0.611	0.614	0.640	0.573	0.639
	(0.066)***	(0.058)***	(0.056)***	(0.054)***	(0.050)***
linitial	-1.460	-0.807	-0.762	-1.440	-1.206
	(0.620)**	(0.378)**	(0.371)**	(0.350)***	(0.278)***
lschool	1.773	0.490	0.684	-0.152	-0.002
	(1.165)	(0.667)	(0.591)	(0.764)	(0.479)
pubdgdp	-1.110	-0.839	-0.798	-0.699	-0.620
	(0.358)***	(0.310)***	(0.279)***	(0.295)**	(0.284)**
lgov		-1.239	-1.167		
		(0.501)**	(0.489)**		
ltrade		1.009	1.127		0.801
		(0.323)***	(0.333)***		(0.328)**
lpi		-0.283	-0.302		
		(0.354)	(0.335)		
lprivo			-0.032		
			(0.050)		
lpop				-7.226	-5.921
				(2.641)***	(2.087)***
linv				2.920	2.202
				(0.662)***	(0.590)***
ltot					3.954
					(2.343)*
lfbal					6.390
					(4.342)
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.010	0.017	0.026	0.012	0.015
AR(2) test	0.344	0.539	0.587	0.349	0.627
Observations	321	302	288	314	261
No. of countries	51	51	51	51	45

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.14: External debt indicators: Linear effects on private savings rate for developing countries

	dbtgdp (1)	dbtexp (2)	pubdgdp (3)	pubdexp (4)	pridgdp (5)	pridexp (6)
l.psr	0.598	0.556	0.595	0.558	0.630	0.640
	(0.057)***	(0.057)***	(0.057)***	(0.056)***	(0.051)***	(0.052)***
lrpdi	0.007	-0.006	0.005	-0.007	-0.001	0.002
	(0.014)	(0.015)	(0.014)	(0.016)	(0.012)	(0.012)
grpdi	0.437	0.381	0.451	0.413	0.526	0.534
	(0.174)**	(0.175)**	(0.173)**	(0.175)**	(0.177)***	(0.179)***
lrir	0.099	0.102	0.101	0.106	-0.002	-0.003
	(0.054)*	(0.050)**	(0.054)*	(0.051)**	(0.025)	(0.025)
ltot	-0.008	-0.011	-0.003	-0.002	0.038	0.031
	(0.034)	(0.031)	(0.034)	(0.031)	(0.032)	(0.030)
oldr	-1.135	-1.012	-1.078	-0.940	-0.602	-0.656
	(0.384)***	(0.395)**	(0.368)***	(0.369)**	(0.226)**	(0.228)***
yngr	-0.385	-0.416	-0.362	-0.377	-0.311	-0.301
	(0.164)**	(0.163)**	(0.158)**	(0.155)**	(0.128)**	(0.134)**
urbpop	-0.010	0.004	-0.009	0.001	-0.020	-0.018
	(0.033)	(0.035)	(0.033)	(0.035)	(0.022)	(0.023)
gsr	-0.714	-0.753	-0.735	-0.775	-0.512	-0.500
	(0.191)***	(0.189)***	(0.195)***	(0.192)***	(0.101)***	(0.104)***
lpi	-0.035	-0.024	-0.035	-0.026	-0.020	-0.021
	(0.010)***	(0.009)**	(0.010)***	(0.009)***	(0.011)*	(0.011)*
debt indicator	-0.016	-0.028	-0.015	-0.024	0.006	0.003
	(0.010)	(0.013)**	(0.010)	(0.011)**	(0.003)**	(0.003)
Hansen J test	1.000	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.017	0.020	0.016	0.020	0.015	0.013
AR(2) test	0.182	0.166	0.193	0.185	0.100	0.107
Observations	194	194	194	194	165	165
No. of countries	45	45	45	45	38	38

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the total external debt-to-GDP, total external debt-to-exports, public external debt-to-GDP, public external debt-to-exports, private external debt-to-GDP, and private external debt-to-exports ratios respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.15: Gross government debt-to-GDP: Linear effects on GDP growth for industrial countries

	(1)	(2)	(3)	(4)	(5)
linitial	-3.598	-3.276	-3.244	-3.327	-2.714
	(0.410)***	(0.614)***	(0.641)***	(0.336)***	(0.345)***
lschool	1.121	0.237	0.144	1.703	0.557
	(0.637)*	(0.595)	(0.598)	(0.796)**	(0.909)
opubdgdp	-0.316	-0.107	-0.116	-0.062	0.355
	(0.211)	(0.126)	(0.124)	(0.158)	(0.102)***
lgov		-1.019	-1.038		
		(0.932)	(0.964)		
ltrade		0.303	0.277		0.106
		(0.367)	(0.367)		(0.398)
lpi		-16.706	-15.903		
		(4.071)***	(4.308)***		
lprivo			0.051		
			(0.142)		
lpop				-2.718	-2.748
				(1.726)	(1.811)
linv				1.672	2.019
				(0.617)**	(0.693)***
ltot					1.989
					(0.723)**
lfbal					11.427
					(4.249)**
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.022	0.006	0.008	0.025	0.025
AR(2) test	0.757	0.897	0.991	0.502	0.513
Observations	153	153	150	153	140
No. of countries	22	22	22	22	22

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.16: Gross government debt-to-GDP: Linear effects on TFP growth for industrial countries

	(1)	(2)	(3)	(4)	(5)
l.prod	0.000	-0.006	0.149	-0.001	-0.002
	(0.007)	(0.006)	(0.154)	(0.009)	(0.008)
linitial	-1.784	-1.805	-1.629	-1.752	-1.100
	(0.316)***	(0.618)***	(0.549)***	(0.304)***	(0.365)***
lschool	0.601	0.116	0.213	0.651	-0.408
	(0.656)	(0.666)	(0.627)	(0.816)	(0.911)
opubdgdp	0.054	0.120	0.138	0.090	0.422
	(0.143)	(0.154)	(0.156)	(0.159)	(0.133)***
lgov		-0.724	-0.717		
		(0.915)	(0.745)		
ltrade		0.254	0.250		0.173
		(0.434)	(0.377)		(0.392)
lpi		-11.337	-12.677		
		(3.983)***	(3.506)***		
lprivo			-0.216		
			(0.224)		
lpop				0.020	0.085
				(1.590)	(1.907)
linv				0.355	0.646
				(0.856)	(0.747)
ltot					2.355
					(0.804)***
lfbal					8.906
					(3.692)**
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.018	0.008	0.003	0.019	0.024
AR(2) test	0.502	0.684	0.327	0.475	0.482
Observations	143	143	141	143	130
No. of countries	22	22	22	22	22

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.17: Gross government debt-to-GDP: Linear effects on capital growth for industrial countries

	(1)	(2)	(3)	(4)	(5)
l.capgrowth	-0.024	-0.023	0.611	-0.021	-0.021
	(0.002)***	(0.002)***	(0.077)***	(0.002)***	(0.002)***
linitial	-5.176	-4.924	-1.831	-4.944	-4.872
	(0.886)***	(0.829)***	(0.743)**	(0.856)***	(0.738)***
lschool	2.514	1.792	1.212	3.588	3.335
	(1.717)	(1.743)	(0.470)**	(1.740)*	(2.042)
opubdgdp	-0.669	-0.489	-0.026	-0.220	0.042
	(0.264)**	(0.250)*	(0.116)	(0.256)	(0.236)
lgov		-1.869	-0.384		
		(0.946)*	(0.305)		
ltrade		0.235	0.069		0.064
		(0.481)	(0.124)		(0.483)
lpi		-16.561	-3.093		
		(4.768)***	(3.198)		
lprivo			0.109		
			(0.141)		
lpop				-2.098	-2.300
				(1.817)	(1.777)
linv				4.612	4.573
				(1.425)***	(1.689)**
ltot					-1.893
					(1.603)
lfbal					8.169
					(5.267)
Hansen J test	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.666	0.202	0.056	0.710	0.959
AR(2) test	0.171	0.112	0.537	0.545	0.535
Observations	143	143	141	143	130
No. of countries	22	22	22	22	22

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the first, second, third, fourth and fifth independent variables sets respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3.18: Debt indicators: Linear effects on private savings rate for industrial countries

	opubdgdp (1)	opubdexp (2)	opubdrev (3)	intgdp (4)	intexp (5)	intrev (6)
l.psr	0.826	0.795	0.814	0.793	0.786	0.796
	(0.068)***	(0.074)***	(0.066)***	(0.069)***	(0.077)***	(0.070)***
lrpdi	0.017	0.022	0.005	0.008	0.007	0.006
	(0.017)	(0.010)**	(0.014)	(0.016)	(0.010)	(0.015)
grpdi	0.991	0.923	1.242	1.265	1.222	1.265
	(0.277)***	(0.249)***	(0.216)***	(0.183)***	(0.203)***	(0.189)***
lrir	-0.278	-0.221	-0.261	-0.324	-0.316	-0.320
	(0.105)**	(0.101)**	(0.106)**	(0.103)***	(0.102)***	(0.104)***
ltot	0.066	0.074	0.037	0.020	0.036	0.024
	(0.044)	(0.044)	(0.024)	(0.072)	(0.021)*	(0.025)
oldr	0.322	0.252	0.042	0.040	0.044	0.060
	(0.170)*	(0.155)	(0.161)	(0.156)	(0.165)	(0.178)
yngr	0.148	0.123	-0.076	-0.195	-0.167	-0.177
	(0.152)	(0.132)	(0.126)	(0.128)	(0.128)	(0.131)
urbpop	0.026	0.029	0.023	0.020	0.027	0.024
	(0.025)	(0.020)	(0.019)	(0.020)	(0.018)	(0.021)
gsr	-0.168	-0.235	-0.284	-0.160	-0.275	-0.194
	(0.053)***	(0.052)***	(0.078)***	(0.089)*	(0.077)***	(0.084)**
lpi	0.035	0.075	0.007	0.076	0.074	0.074
	(0.098)	(0.100)	(0.082)	(0.033)**	(0.030)**	(0.034)**
debt indicator	-0.006	-0.014	-0.008	0.003	-0.008	-0.000
	(0.005)	(0.004)***	(0.003)**	(0.005)	(0.003)**	(0.004)
Hansen J test	1.000	1.000	1.000	1.000	1.000	1.000
AR(1) test	0.006	0.005	0.007	0.009	0.006	0.007
AR(2) test	0.836	0.725	0.858	0.797	0.793	0.770
Observations	130	130	121	131	131	131
No. of countries	22	22	22	24	24	24

Estimated using one-step system GMM dynamic panel-data estimator with time dummies (Arellano and Bover (1995); Blundell and Bond (1998)). Columns (1), (2), (3), (4) and (5) display estimates for the gross government debt-to-GDP, gross government debt-to-exports, gross government debt-to-revenues, interest payments-to-GDP, interest payments-to-exports, and interest payments-to-revenues ratios respectively. The Hansen J test reports the p-values of a test of over-identifying restrictions. The AR(1) and AR(2) tests report the p-values of the Arellano-Bond test for autocorrelation. Robust standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Chapter 4

Industry Diversification, Financial Development and Productivity-Enhancing Investments

4.1 Introduction

For several decades, long-run productivity growth and short-run business cycles have been investigated separately in the economics literature. Recently, however, there has been a return to the Schumpeterian view of growth and cycles as a unified phenomenon. This development is especially taken into account by the endogenous growth literature with quality-improving innovations (Aghion and Howitt, 1998). Endogenous growth theory with quality-improving innovations argues that growth is generated by a random sequence of quality improving (or "vertical") innovations that themselves result from (uncertain) R&D research activities. Technical progress makes existing technologies or products obsolete, emphasizing Schumpeter's process of "creative destruction". On the other hand, the endogenous growth literature also emphasizes the existence of expanding variety innovations ("horizontal innovation"): a discovery consists of the technical knowledge required to manufacture a new good that does not displace existing ones. Therefore, innovation takes the form of an expansion in the variety of available products (Gancia and Zilibotti, 2005). These two strands of the literature are not mutually exclusive, but complementary, and theoretical models have been developed that take into account both vertical and horizontal innovation (Howitt, 1999).

Regarding the link between financial development and economic growth, there is a vast literature that is summarized in Levine (2005). Among the papers most closely related to this paper, the following can be mentioned. Aghion et al. (2005) study how credit constraints affect the cyclical behavior of productivity-enhancing investment. They state that a less developed financial system implies both higher aggregate volatility and a lower mean growth rate. Aghion et al. (2005b) study the effect of financial development on convergence. They predict that any country with more than some critical level of financial development converge to the growth rate of the world technology frontier, and that all other countries have a strictly lower long-run growth rate. However, unlike the micro-founded literature on financial markets and institutions (Bhattacharya et al., 2004), these two papers simply assume credit constraints in their model. Acemoglu and Zilibotti (1997) model the relationship between cross-sectional risk, diversification, and growth. They find that that the variability of growth decreases with economic development, and that productivity endogenously increases as the diversification opportunities improve. Their results are driven by the assumption that less developed countries specialize in low risk and low return sectors. However, this assumption is refuted by the results of the empirical paper by Koren and Tenreyro (2005), who find that the opposite is true. Carranza and Galdon-Sanchez (2004) build a model of financial intermediation that analyze output variability during the development process. They find that output is more volatile in middle-income economies than in both low and high-income economies.

The objective of this paper is to study the role of the financial system in promoting macroeconomic stability and growth. It develops a simple growth model where the financial system has a central role to play. The model is similar to Aghion et al. (2005), but instead of assuming exogenous credit constraints, it derives an endogenous micro-founded model of the financial system. The financial system is modelled as an imperfect capital market with informational asymmetries and moral hazard regarding agents' choices as in Holmström and Tirole (1998). Firms engage both in vertical and horizontal innovation, but have to finance liquidity shocks for these innovations to be successful. Successful vertical innovation is the driving force behind the growth of the economy. Horizontal innovation does not affect the growth rate directly, but generates new industrial sectors, which diversify the economy. Industry diversification deepen the financial system by improving its probability of supplying enough liquidity to firms at the aggregate level. Thus, a more diversified economy has a higher probability of successful horizontal and vertical innovations. Fluctuations across time arise because the fraction of firms fulfilling their investment projects at each period of time varies. Economies that are more diversified, and thus more financially developed, have higher mean growth rates than economies that are less diversified. The volatility of the growth rate is initially increasing, but becomes decreasing at intermediate and high levels of industry diversification. In this model, there is an important role for the government in subsidizing innovations, especially horizontal innovation, to promote financial development and economic growth. The active role of the government is especially suitable at early stages of financial development.

This paper offers several new insights with respect to the existing literature on financial development and growth. The papers by Aghion et al. (2005) and Aghion et al. (2005b) take the level of financial development as an exogenous parameter, and do not model endogenously how the growth process affect financial development. In contrast, by combining the endogenous growth literature with an explicit micro-founded model of the financial system, this paper endogenously model the development of the financial system as a consequence of the growth process. Nonetheless, it is reassuring that the conclusions of this paper, regarding the causal effect of financial development on growth, are in line with those of Aghion et al. (2005) and Aghion et al. (2005b). Another contribution of this paper is to explain financial development as a consequence of industry diversification. In our model, industry diversification is part of the growth process in the sense that it is a consequence of horizontal innovation. In that way, horizontal innovation has a key role to play in the development of the financial system. Although the argument that diversification helps dampen aggregate risk has been used previously (see for example Acemoglu and Zilibotti (1997)), no explicit micro-founded model has used this feature to endogenously explain financial development as part of the growth process.

Section 4.2 presents the basic setup of the model, which follows closely Holmström and Tirole (1998). The aggregate demand for liquidity and the role of the financial intermediary is introduced in section 4.3. The consequences of industry diversification for the financial system, and the issue of partial liquidation is presented in section 4.4. Section 4.5 analyzes the relation between industry diversification, financial development and economic growth. It also discusses the consequences of government subsidies to innovation. The conclusions are discussed in section 4.6.

4.2 Model

The economy is characterized by a simple, dynamic moral hazard model with overlapping generations of three-period-lived agents as in Holmström and Tirole (1998).[1] The economy is populated by three types of agents, firms (or entrepreneurs), investor (or consumers) and an intermediary (or bank). There is only one good that is used for both consumption and investment. All agents are risk-neutral with an additively separable utility function over undiscounted consumption streams. Each firm is indexed by i, has access to an investment project with constant returns to scale, and belongs to a certain industry j. The total number of different industries existing in the economy is J. Each generation is

[1] The basic setup of this model is also used by Holmström and Tirole (2000).

indexed by s, which is the moment of time when they were born.[2]

For an initial investment T_sI in period 0, the investment project of firm i returns RT_sI in period 2 if it succeeds, where T_s is the current available level of aggregate knowledge for generation s, I is the investment scale, and R is the gross rate of return of the project.[34] If the project fails, the return is 0. In period 1, all the firms belonging to industry j are hit by a random liquidity shock C_j, which has to be financed for the projects not to be abandoned (in which case the return is 0). Note that in period 1, the total number of shocks that hit the economy is J, i.e. there is one shock for each industry j. The liquidity shocks, or adjustment cost shocks, are proportional to the initial investment T_sI, i.e. $C_j = c_jT_sI$. In addition, the industry-level shocks c_j are independently and identically distributed with finite mean and variance. The shocks have a continuous distribution function $F(c_j)$ on $[0, \infty]$, with a probability density function $f(c_j)$. Note that the shocks are also independently and identically distributed across generations s.

In addition to the economic return, successful investment projects generate both vertical and horizontal technical innovation in period 2. Liquidated or abandoned projects do not produce any technological innovation. Vertical innovation improves the quality of already existing products, and increases the knowledge T of the economy. We assume, as Aghion et al. (2005) does, that the knowledge accumulated by generation s is available to generation $s+1$, and that the creation of knowledge is proportional to the initial investment T_sI of generation s. Thus, the dynamics of the knowledge T of the economy evolves according to

$$\Delta T_{s+1} = \int_i vIT_s\ell_s^i, \tag{4.1}$$

where v is a vertical R&D productivity parameter and ℓ_s^i is an indicator variable equal to 1 if the liquidity shock of firm i has been financed and the project is successful, and 0 otherwise. Following the endogenous growth literature, the growth rate of the economy in this model is equal to the growth rate of knowledge T (see for example Aghion and Howitt (1998, ch. 2)). In terms of our representation of the growth process, this assumption in combination with the specific functional form of equation (4.1) imply that productivity growth is increasing in the level of productivity-enhancing investments. It is this characteristic that interlinks our growth model with the endogenous growth theory.[5] Note also that in this model,

[2]In our model, the concept of "time" refers to the evolution across generations s. At each moment of time s, there are three generations coexisting at the same time. This is a consequence of this being an overlapping generations model where agents live for three periods.

[3]We assume that all the firms and industries are of equal size, and therefore we skip the i and j indexes when using them is not essential.

[4]All the variables are expressed in proportion to T in order to guarantee a balanced growth path.

[5]In other words, this paper assumes that economic growth is a consequence of technological progress, and does not build a fully specified endogenous growth model where the process of innovation is modelled.

the economy is always at steady-state and, thus, at the balanced growth path.

Horizontal innovation creates new products (or industries), and is associated with increases in the total number of industries J over time. Thus, horizontal innovation implies an increase in the industry diversification of the economy. J evolves according to

$$\Delta J_{s+1} = \int_i hIJ_s\ell_s^i, \tag{4.2}$$

where h is a horizontal R&D productivity parameter and ℓ_s^i is an indicator variable equal to 1 if the liquidity shock has been financed and the project is successful, and 0 otherwise. From equations (4.1) and (4.2), it is clear that horizontal innovation does not directly affect the productivity of the economy. This assumption is based on Howitt (1999). In his model, the growth rate of the economy is not altered by the number of existing products because it is assumed that, as the number of products grow, the contribution of each vertical innovation with respect to any given product have a smaller impact on the aggregate economy. The role of horizontal innovation is to eliminate the "scale effects" generated by the growth of the population. As will become clearer in sections 4.4 and 4.5, the role of horizontal innovation in our model is to deepen the financial system. Specifically, an increased diversification (a larger J) improves the intermediary's chances to provide liquidity to firms in period 1.

The total output at time s is given by

$$Y_s = \int_i RT_{s-2}I\ell_{s-2}^i, \tag{4.3}$$

where ℓ_{s-2}^i is an indicator variable equal to 1 if the liquidity shock of firm i has been financed and the project is successful, and 0 otherwise. Note that the output at time s is the realized output of the investment projects undertaken by firms at time $s-2$.

Each firm has a period 0 endowment of cash, $T_sA > 0$, and no endowments in periods 1 and 2. In order to implement a project of scale $T_sI > T_sA$, the firm must borrow $T_s(I-A)$ from outside investors. In addition, it needs to finance the industry-level liquidity shock C_j in period 1. The firm uses the project's return in period 2 as collateral to obtain these loans. Investment projects are subject to moral hazard, as in Holmström and Tirole (1998), because each firm privately chooses the probability of success of the project after the continuation decision in period 1. The probability of success may be high (p_H) or low (p_L), conditional on the effort exerted by the firm, where $p_H - p_L \equiv \Delta p > 0$. If the firm exerts a low effort, it still enjoys a private benefit, $BT_sI > 0$, which is proportional to the initial investment.

For the investment to be profitable, the expected return of the project must exceed the initial investment plus the adjustment cost. Therefore, in period 1, the investment is continued if and only if the industry-level liquidity shock c_j is less or equal to $\tilde{c}$ ($c_j \leq \tilde{c}$), where $\tilde{c}$ is a certain threshold for which the investment has a positive net present value. We assume that the continuation condition holds only for p_H, but not for p_L, i.e. the project's net present value is positive only if the firm exerts a high effort. The positive NPV condition per unit of investment under industry-level liquidity shocks is

$$\max_{\tilde{c}}\{F(\tilde{c})p_H R - 1 - \int_0^{\tilde{c}} c_j f(c_j)dc_j\} > 0,$$

where $F(\tilde{c})p_H R$ is the expected gross return given that the firm exerts a high effort, $F(\tilde{c})$ is the probability that the industry-level liquidity shock c_j is less or equal to $\tilde{c}$, and $\int_0^{\tilde{c}} c_j f(c_j)dc_j$ is the expected value of the liquidity shock given that $c_j \leq \tilde{c}$. Note that the upper limit of integration is given by $\tilde{c}$. The reason is that projects with liquidity shocks above $\tilde{c}$ are abandoned, and thus have a liquidity demand equal to 0.

As explained above, firms need to get finance from outside investors, and therefore a contract between the parts must be set up. This loan agreement between the firm and outside investors has to specify the scale of the investment I, the payoffs to the parts and a "cutoff" threshold for the liquidity shock such that it is optimal to continue if and only if

$$c_j \leq c^*.$$

For ease of exposition, all the quantities are "detrended" from now on, i.e. they are divided by the current technology level T_s. Figure 4.1 presents a simplified account of the events at the firm-level and for the intermediary. The role of the intermediary is explained in section 4.3.

For the contract between the firm and outside investors to be optimal, it has to be designed so that the firm has incentives to exert a high effort. Further, the design must also take into account that outside investors have to break-even. Regarding the firm's incentive problem, the expected return that the firm obtains given a high effort must exceed the expected return it obtains given a low effort plus the private benefit. This implies that $p_H R_f(c_j) \geq p_L R_f(c_j) + B$, where $R_f(c_j)$ is the amount the firm earns if the project succeeds (given a liquidity shock c_j). Thus, the payoff to the firm that is consistent with its incentives to exert a high effort is

$$R_f(c_j) \geq R_b \equiv \frac{B}{\Delta p}. \tag{4.4}$$

Regarding outside investors, the payoff they receive if the project succeeds is $R - R_f(c_j)$, which is the return that is left after discounting the payoff to the firm. Thus, the payment to outside investors that is consistent with their break-even condition is

$$F(c^*)[p_H(R - R_f(c_j))]I \geq I - A + \int_0^{c^*} c_j f(c_j)dc_j I, \tag{4.5}$$

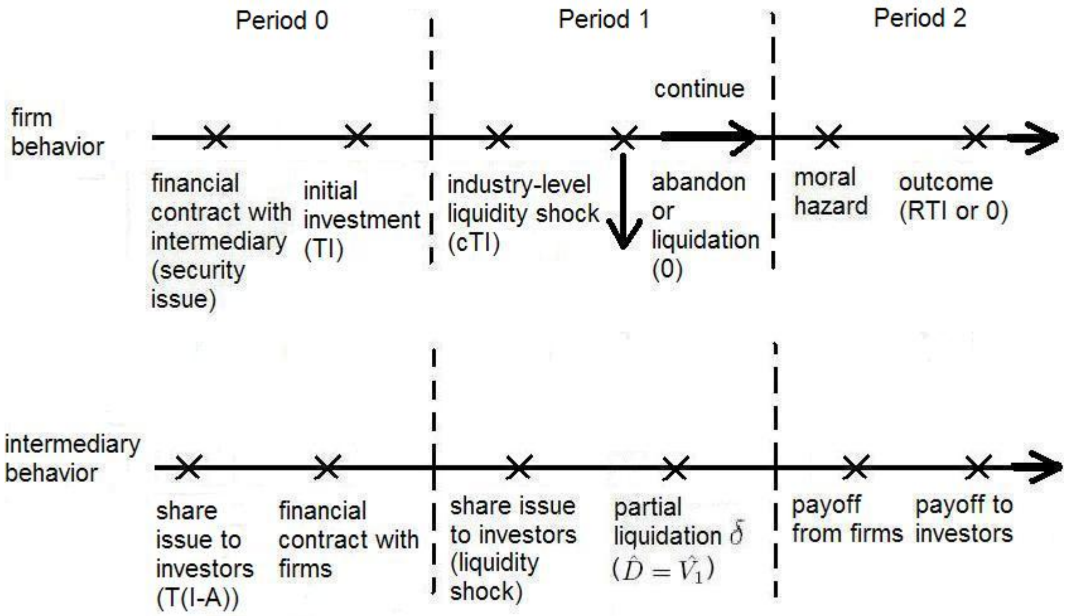

Figure 4.1: Firm and intermediary behavior

where the left hand side is the expected pledgable income, and the right hand side is the investors' period-0 outlay, $I - A$, plus the expected liquidity demand, $\int_0^{c^*} c_j f(c_j) dc_j I$. The expected pledgable income is given by the probability that the liquidity shock is equal or below c^*, $F(c^*)$, and what is left to outside investors given that the firm exerts a high effort, $[p_H(R - R_f(c_j))]I$. Note that by setting $R_f(c_j) = R_b$ in equations (4.4) and (4.5), the firm maximizes the amount that it can pay to outside investors (per unit of I), $c_p \equiv p_H(R - (B/\Delta p))$. We call c_p the "pledgable income" because we have assumed that the firm uses the return of its project in period 2 as collateral for obtaining the funds from outside investors.

Given this setup, the firm maximizes the return per unit of its own investment A by optimally choosing the amount to borrow from outside investors and the optimal cutoff value. The amount borrowed from outside investors determines the investment scale I of the project. The firm's objective function is

$$\begin{aligned} U_b &= m(c^*)I \\ &= m(c^*)k(c^*)A, \end{aligned} \tag{4.6}$$

where

$$m(c^*) \equiv F(c^*)p_H R - 1 - \int_0^{c^*} c_j f(c_j) dc_j$$

is the project's expected net return per unit of investment,

$$I = k(c^*)A \tag{4.7}$$

is the investment scale, and

$$\begin{aligned} k(c^*) &= \frac{1}{1+\int_0^{c^*} c_j f(c_j)dc_j - F(c^*)p_h(R-\frac{B}{\Delta p})} \\ &= \frac{1}{1+\int_0^{c^*} c_j f(c_j)dc_j - F(c^*)c_p} \end{aligned} \quad (4.8)$$

is the equity multiplier, which determines the maximum investment in period 0 that allows outside investors to break-even (the firm's "debt capacity"). The debt capacity is maximal when the threshold c^* is equal to the unit expected pledgeable income c_p, in which case $k(c_p) > 1$. This becomes clearer by integrating equation (4.8) by parts, which is done in in subsection 4.A1 of the appendix.

The maximization of the firm's objective function (4.6) is equivalent to minimizing the expected unit cost $c(c^*)$ of effective investment:

$$\min_{c^*} c(c^*) \equiv c^* + \frac{1-\int_0^{c^*} F(c_j)dc_j}{F(c^*)}. \quad (4.9)$$

The formal proof of this equivalence is in subsection 4.A1 of the appendix. The first order condition for (4.9) is

$$\int_0^{c^*} F(c_j)dc_j = 1, \quad (4.10)$$

which implies that at the optimum, the threshold liquidity shock is equal to the expected unit cost of effective investment:

$$c(c^*) = c^*. \quad (4.11)$$

Thus, at the optimum the firm's net return is[6]

$$U_b = \frac{c_r - c^*}{c^* - c_p} A, \quad (4.12)$$

where $c_r \equiv p_H R$ is the period 1 expected gross return per unit of investment, $c_p \equiv p_H(R-(B/\Delta p))$ is the period 1 pledgeable unit return from investment, and c^* is the optimal continuation threshold level. Furthermore, the optimal threshold c^* lies between the pledgeable income c_p and the expected gross return c_r:

$$c_p < c^* < c_r. \quad (4.13)$$

This is a consequence of both the expected net return per unit of investment $m(c^*)$ and the equity multiplier $k(c^*)$ being decreasing above the expected gross return

[6]This result is easier to corroborate by considering equations (4.32) and (4.33), from subsection 4.A1 in the appendix, in combination with equation (4.11).

c_r, and increasing below the pledgeable income c_p. Condition (4.13) is consistent with definition (4.12) because if the optimal threshold c^* exceeds the expected gross return c_r, the project can not be financed profitably. Further, if the optimal threshold c^* is lower than the pledgeable income c_p, the debt capacity and the borrower's utility is infinite. Note that the optimal threshold c^* lies between the pledgeable income c_p and the expected gross return c_r, but does not depend on either of them. In addition, from equation (4.8) it is clear that at the optimum the investment scale I depends only on the pledgeable income c_p.

4.3 Intermediation and aggregate liquidity

In the preceding section, the basic setup of the model has been presented. We have characterized the aggregate behavior of the economy across time regarding technological knowledge and industry diversification. The behavior of firms regarding their incentives have been analyzed, and the optimal continuation threshold level have been established. In this section, we continue to characterize the economy by introducing the role of the intermediary in the economy. The aggregate demand and supply of liquidity is analyzed.

We assume that there is no exogenously given storage technology so that wealth cannot be transferred from one period to the other through cash and/or private assets (such as real state). The only way to transfer wealth is through financial instruments, such as shares and/or securities.[7] In periods 0 and 1, the intermediary (a bank) issues shares to investors, which are claims on its financial position in period 2. These shares are priced so that investors break even ex ante. With the proceeds, the intermediary buys up all the external claims on firms (securities) in periods 0 and 1.[8] With the security issues, firms are able to finance their initial investment in period 0, and the industry-level liquidity shock in period 1.

Concretely, in period 0, the intermediary issues shares to investors in order to lend $I - A$ to each firm for the initial investment. Also it agrees with firms on an irrevocable line of credit in the amount c^*I to cover the period 1 industry-level liquidity shock. This agreement is conditional on the intermediary's ability to collect sufficient aggregate liquidity in period 1. Firms are priced so that the intermediary breaks even ex ante on each firm issue. In period 1, it sells shares to investors in the amount V_1, which reflects the total value of external claims on the aggregate conglomerate of firms, and if that amount is enough to finance

[7] If intertemporal wealth transfers is possible through cash and/or private assets, there is no role for the intermediary, and no shortage of liquidity. We make this assumption, following Holmström and Tirole (1998), because we are interested in studying the endogenous supply of liquidity, and the role of the financial system in supplying liquidity.

[8] Another way to transfer wealth can be through the financial market, but as Holmström and Tirole (1998) demonstrate, firms are unable to finance liquidity shocks by individually issuing securities, and buying shares of a market portfolio.

the aggregate demand for liquidity $\bar{D}$, the intermediary can honor its promises to firms. Note that the intermediary pools firms risks, and subsidizes firms with a high liquidity demand by allowing them to draw on the market value of firms that experience a low liquidity demand. The ability to pool firms' risks is one of the two key features that characterize the intermediary. The second key attribute is discussed in section 4.4.

Assuming there is a continuum of firms with unit mass, the aggregate demand for liquidity in period 1 is

$$\begin{aligned}\bar{D} &= (\frac{c_1 J_1(c^*) + ... + c_J J_J(c^*)}{J})I \\ &= \frac{I}{J}\sum_{j=1}^{J} c_j J_j(c^*), \end{aligned} \tag{4.14}$$

where I is the representative firm's initial investment scale, c_j is the liquidity shock for industry sector j, $J_j(c^*)$ is an indicator variable for industry j, which equals 1 if $c_j \leq c^*$, and 0 if $c_j > c^*$, and J is the number of existing industries. Note that only those firms with liquidity shocks below c^* continue with their investment project in period 1, which is the reason we have the indicator variable $J_j(c^*)$ for each industry j. The total value of external claims on the productive sector in period 1 is

$$\begin{aligned}V_1 &= \frac{\sum_{j=1}^{J} J_j(c^*)}{J} c_p I \\ &= F^J(c^*) c_p I, \end{aligned} \tag{4.15}$$

where $F^J(c^*)$ is the observed fraction of firms with liquidity shock below the optimal threshold c^*, c_p is the pledgeable unit return from investment, $J_j(c^*)$ is the indicator variable for industry j used in equation (4.14), and J is the number of existing industries.

The intermediary is able to finance all firms as long as the value of external claims on the productive sector V_1 is larger than the aggregate demand for liquidity $\bar{D}$, i.e. the value of the investment portfolio $S_1 \equiv V_1 - \bar{D} > 0$. Using equations (4.14) and (4.15), the value of the investment portfolio S_1 is

$$\begin{aligned}S_1 &= V_1 - \bar{D} \\ &= \frac{Ic_p}{J}\sum_{j=1}^{J} J_j(c^*) - \frac{I}{J}\sum_{j=1}^{J} c_j J_j(c^*) \\ &= \frac{I}{J}\sum_{j=1}^{J}(c_p - c_j) J_j(c^*), \end{aligned} \tag{4.16}$$

where c_j is the liquidity shock for industry sector j, c_p is the pledgeable unit return from investment, $J_j(c^*)$ is the indicator variable for industry j, I is the investment scale, and J is the number of existing industries.

As a benchmark case, consider a completely diversified economy. When this is the case, $J \to \infty$ and the value of the investment portfolio S_1 is equal to $I - A$, which is positive by assumption. This follows from

$$\begin{aligned} \text{plim}_{J\to\infty} S_1 &= \text{plim}_{J\to\infty} V_1 - \text{plim}_{J\to\infty} \bar{D} \\ &= F(c^*)c_p I - \int_0^{c^*} c_j f(c_j) dc_j I \qquad (4.17) \\ &= I - A, \qquad (4.18) \end{aligned}$$

where the total value of external claims on the productive sector V_1 has $F(c^*)c_p I$ as its limit as $J \to \infty$ because $F^J(c^*)$ tends to $F(c^*)$ as $J \to \infty$. Note that $F(c^*)$ is both the ex ante probability that a given firm faces a liquidity shock c_j equal to or below the optimal threshold c^*, and the realized fraction of firms that continue in period 1 when $J \to \infty$. Regarding the aggregate demand for liquidity in period 1 $\bar{D}$, its limit as $J \to \infty$ is equal to $\int_0^{c^*} c_j f(c_j) dc_j I$ because $\sum_{j=1}^{J} c_j J_j(c^*)/J$ tends to $\int_0^{c^*} cf(c)dc$ as $J \to \infty$. Equation (4.17) becomes equation (4.18) by combining the investment scale definition from equation (4.7) with the equity multiplier definition from equation (4.8).

The expected value of the aggregate demand for liquidity $\bar{D}$ conditional on the industry-level liquidity shocks c_j being equal or less than the optimal threshold c^*, $E(\bar{D}|M)$ with $M = \{c_j \leq c^*\}$, is equal to the deterministic value $\int_0^{c^*} c_j f(c_j) dc_j I$. Further, $E(V_1|M)$ is equal to the deterministic value $F(c^*)c_p I$. This analysis implies that the expected value of the value of the investment portfolio S_1 conditional on the industry-level liquidity shocks c_j being equal or less than the optimal threshold c^*, $E(S_1|M)$, is equal to the positive value $I - A$, as in equation (4.18). This result is important for the discussion of the next section, where we analyze the relationship between the degree of diversification and partial liquidation when there is an aggregate liquidity shortage, i.e. when $S_1 < 0$. The distribution function of S_1 has a central role in this discussion.

4.4 Diversification and partial liquidation

As seen in the last section, when the economy is completely diversified ($J \to \infty$), the value of the investment portfolio S_1 is positive and equal to $I - A$. Thus, there is no aggregate liquidity shortage, and all the investment projects with liquidity shocks below the optimal threshold c^* receive funding from the intermediary. When the economy is not completely diversified, it is no longer true that the value of the investment portfolio $S_1 = I - A > 0$, and S_1 may be negative. If that is the case, the intermediary needs to exercise partial liquidation because the aggregate demand for liquidity is greater than what it can collect from investors, i.e. there is an aggregate shortage of liquidity. Partial liquidation implies that only the fraction δ of firms are allowed to continue in period 1. Note that we are assuming that partial liquidation is only possible at the industry level, and not at the firm level, i.e. the scale of an individual project cannot be reduced.[9] The ability to exercise partial liquidation is the second key attribute of the intermediary, beside its ability to pool firms' risks, as explained in section 4.3.

In terms of the concrete implementation of partial liquidation, in period 1, after the liquidity shocks and the values of V_1 and $\bar{D}$ are realized, the intermediary decides which firms to liquidate. The aggregate demand for liquidity after partial liquidation becomes

$$\hat{D} = \frac{I}{J} \sum_{j=1}^{J} c_j J_j(c^*) L_j(S_1), \tag{4.19}$$

where I is the investment scale, J is the number of existing industries, c_j is the liquidity shock for industry sector j, $J_j(c^*)$ is an indicator variable for industry j, which equals 1 if $c_j \leq c^*$, and 0 if $c_j > c^*$, and $L_j(S_1)$ is an indicator variable for industry j, which equals 0 if the intermediary decides that industry j should be liquidated, and 1 otherwise.[10] $L_j(S_1)$ is a variable that depends on the realized value of S_1 because as explained above partial liquidation is only relevant when there is an aggregate liquidity shortage, i.e. $S_1 < 0$. The total value of external claims on the productive sector in period 1 after partial liquidation becomes

$$\begin{aligned} \hat{V}_1 &= \frac{\sum_{j=1}^{J} L_j(S_1)}{J} \frac{\sum_{j=1}^{J} J_j(c^*)}{J} c_p I \\ &= \delta F^J(c^*) c_p I, \end{aligned} \tag{4.20}$$

where $\delta = \sum_{j=1}^{J} L_j(S_1)/J$ is the fraction of firms that are liquidated by the intermediary, $F^J(c^*)$ is the observed fraction of firms with liquidity shock below the optimal threshold c^*, c_p is the pledgeable unit return from investment, and I is the investment scale. Note that δ is a variable that adopts values between 0 and 1, and depends on the realized value of the investment portfolio S_1. δ is a positive function of the value of the investment portfolio S_1 because the more negative S_1 becomes, the smaller the fraction of firms that can continue. When S_1 is positive, there is no aggregate shortage of liquidity, and there is no need for partial liquidation, i.e. $\delta = 1$. As seen in section 4.3, this is always the case when the economy is completely diversified. Figure 4.2 presents graphically the relationship between S_1 and δ.

The value of the investment portfolio after partial liquidation $\hat{S}_1 \equiv \hat{V}_1 - \hat{D}$ must be zero. Thus, the intermediary decides which firms to liquidate so that

[9] If the scale of an individual project could be partially liquidated, there would be no role for the intermediary, and firms would be able to finance the liquidity shock by issuing securities directly to investors (Holmström and Tirole, 1998).

[10] Note, however, that although all the firms of the same industry have the same liquidity shock and liquidity needs, it is not necessary to liquidate the whole industry. If only a fraction of the firms of industry j are liquidated, $L_j(S_1)$ may assume a value between 0 and 1, instead of 1, which represents the fraction of firms of industry j that are allowed to continue.

$\hat{S}_1 = 0$, i.e. there is no aggregate liquidity shortage. Note that the intermediary's decision to liquidate industry j ($L_j(S_1) = 0$) affects negatively both the value of the aggregate demand for liquidity after partial liquidation in equation (4.19) and the total value of external claims on the productive sector after partial liquidation in equation (4.20). Therefore, the intermediary optimally implements partial liquidation by not financing the liquidity shocks of those industries that have been hit by the largest liquidity shocks. Then, $\hat{D}$ decreases at a higher speed than $\hat{V}_1$, which eventually makes them become equal, i.e. $\hat{S}_1 = 0$. Note also that although all the firms of the same industry have the same liquidity demand, it is not necessary to liquidate the whole industry if that implies that $\hat{S}_1 > 0$. In this case, it is optimal for the intermediary to allow some of the firms in this industry to continue.[11] Figure 4.1 presents a simplified account of the events at the firm-level and for the intermediary.

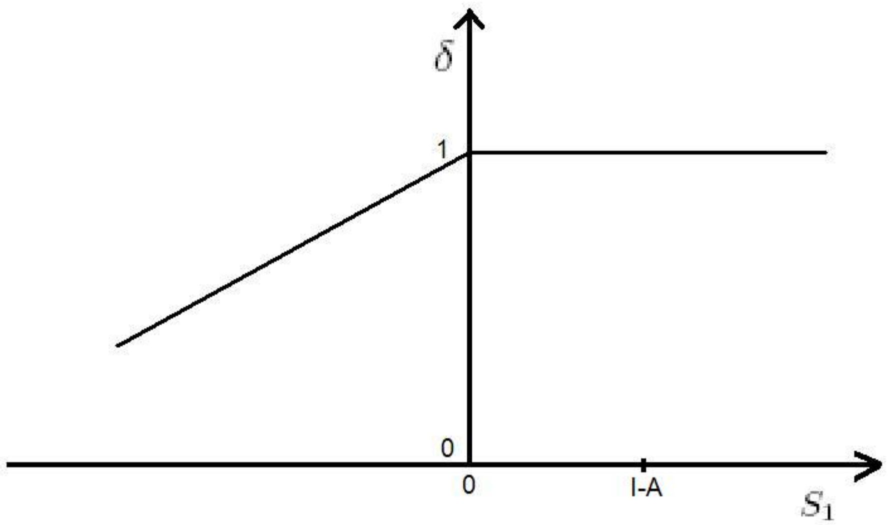

Figure 4.2: Relationship between S_1 and δ

Now that we have established what happens after the realization of the liquidity shocks, we go back a step and study the distribution function of S_1 before the realization of the liquidity shocks. This analysis will clarify the relationship between the value of the investment portfolio S_1 and the fraction of firms allowed to continue in period 1 δ. Concretely, we next study how the number of industries J affects the distribution function of the value of the investment portfolio S_1. To do so, we first have to analyze the expected value of the value of the

[11]It can be assumed that the firms that continue from this industry are drawn randomly.

investment portfolio S_1, its variance, and how the number of industries J affects its variance. Recall that the number of industries J is also equal to the number of independently and identically distributed liquidity shocks c_j hitting the economy.

As analyzed in section 4.3, the expected value of the value of the investment portfolio S_1 conditional on the liquidity shocks being below the optimal threshold c^* is the deterministic positive amount $I - A$. To study the conditional variance of S_1, we redefine the definition of S_1 in equation (4.16) as follows

$$\begin{aligned} S_1 &= \frac{I}{J}\sum_{j=1}^{J}(c_p - c_j)J_j(c^*) \\ &= \frac{I}{J}\sum_{j=1}^{J} w_j, \end{aligned} \tag{4.21}$$

where $w_j = (c_p - c_j)J_j(c^*)$ is a new variable. Moreover, since c_p is a constant, $0 \leq J_j(c^*) \leq 1$, and c_j has a finite variance, we conclude that w_j also has a finite variance σ_*^2. Note that w_j has the same finite variance σ_*^2 for all j because we have assumed that the liquidity shocks c_j are independently and identically distributed. Using the new definition of S_1 from equation (4.21), its conditional variance is

$$\begin{aligned} Var(S_1|M) &= Var(\frac{I}{J}\sum_{j=1}^{J} w_j|M) \\ &= \frac{I^2}{J^2}\sum_{j=1}^{J}\sigma_*^2 \\ &= \frac{I^2}{J}\sigma_*^2, \end{aligned} \tag{4.22}$$

which implies that $Var(S_1|M) \to 0$ as $J \to \infty$. Moreover, $Var(S_1|M)$ is decreasing in J, i.e. the conditional variance of the value of the investment portfolio S_1 becomes smaller, the more diversified the economy is.

The above analysis implies that the probability density function of the value of the investment portfolio S_1 is centered on $I - A > 0$. Further, the density function has a spread that is decreasing in J, i.e. the density function is more spread when the economy is less diversified. Thus, the weight in the tails increases when the economy is less diversified, which also means that variable S_1 becomes more variable or risky (Rothchild and Stiglitz, 1970). This, in turn, implies that the $Prob(S_1 < 0|M)$ is larger when J is smaller (see Figure 4.3). Note also that the density function collapses to $I - A > 0$ when J reaches infinity.

The expected value of the fraction of firms allowed to continue in period 1 $E(\delta|N)$, where $N = \{\hat{S}_1 = 0\}$ means that partial liquidation has eliminated

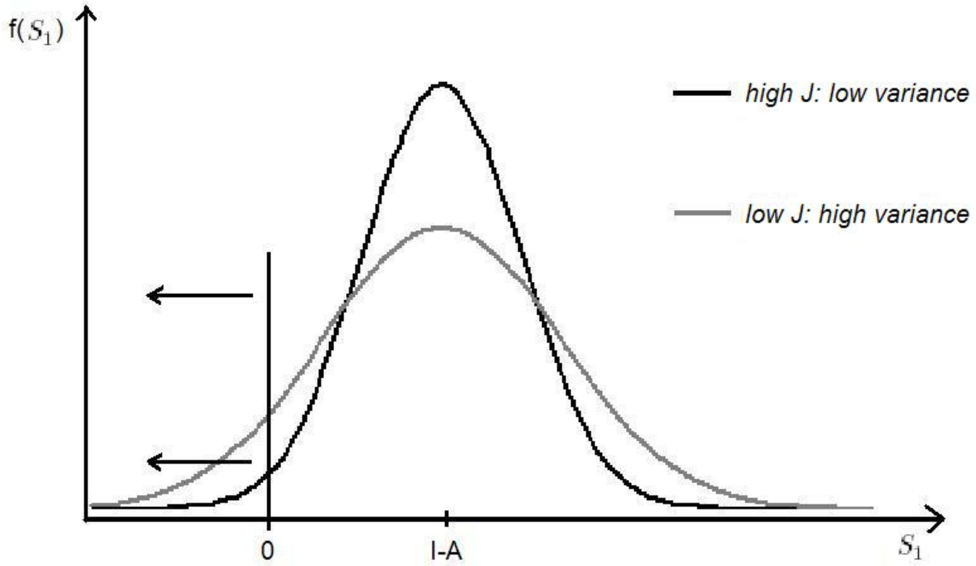

Figure 4.3: Probability density function of S_1

aggregate liquidity shortage, is

$$\begin{aligned} E(\delta|N) &= E(\frac{\sum_{j=1}^{J} L_j(S_1)}{J}|M) \\ &= E(L_j(S_1)|M) \\ &= Prob(L_j(S_1) = 1|N), \end{aligned} \tag{4.23}$$

where $Prob(L_j(S_1) = 1|N)$ is the probability that $L_j(S_1)$ is equal to 1, i.e. the probability that industry j is not liquidated by the intermediary. Note that the probability that industry j is not liquidated by the intermediary $Prob(L_j(S_1) = 1|N)$ is negatively related with the probability that the value of the investment portfolio S_1 is negative $Prob(S_1 < 0|M)$. The reason is that the larger the probability that there be an aggregate liquidity shortage due to S_1 being negative, the smaller is the probability that a certain industry j is not liquidated by the intermediary. Combining the fact that there is a negative relationship between $Prob(L_j(S_1) = 1|N)$ and $Prob(S_1 < 0|M)$, and that $Prob(S_1 < 0|M)$ is larger when J is smaller, implies that $E(\delta|N)$ is a positive function of J. The expected fraction of firms that continue $E(\delta|N)$ is higher when the economy is more diversified because there is a higher probability that the financial intermediary is able to collect enough liquidity to meet the aggregate demand for liquidity. This is a key result for the analysis in section 4.5.

4.5 Diversification and growth

The aggregate return in period 2 for generation s is $\delta_s F_s^J(c^*)p_H RT_s I$, where δ_s is the fraction of firms that are not liquidated by the intermediary, $F_s^J(c^*)$ is the fraction of firms that are hit by liquidity shocks below the optimal threshold c^*, p_H is the fraction of successful projects, R is the gross return, and $T_s I$ is the initial investment. Note that the aggregate return in period 2 with partial liquidation becomes $\delta_s F_s^J(c^*)p_H RT_s I$, which is at most equal to the aggregate return without partial liquidation, $F_s^J(c^*)p_H RT_s I$, because $0 \leq \delta \leq 1$. Note also that we have included the s subscript to emphasize the fact that the realizations of δ and $F^J(c^*)$ differ across generations. The ultimate reason being that each generation s suffers different realizations of the liquidity shocks c_j. Recall also that each generation s is hit by a total of J liquidity shocks in period 1.

From equation (4.1), the growth rate of the economy due to vertical innovation is

$$\frac{\Delta T_{s+1}}{T_s} = \delta_s F_s^J(c^*)p_H vI, \tag{4.24}$$

where the integral and the indicator variable ℓ_s^i in equation (4.1) have been replaced by $\delta_s F_s^J(c^*)p_H$ in equation (4.24), which is the fraction of firms that have financed the liquidity shocks c_j and have finished successfully the investment projects, i.e. the fraction of firms for which the indicator variable ℓ_s^i equal 1. Note that this result implies that fluctuations across generations arise because the fraction of firms fulfilling their investment projects varies for each generation s. As noted above this is a consequence of different realizations of δ and $F^J(c^*)$ for each generation s. Interestingly, as our explanation of fluctuations is not dependent on the assumption made regarding the return of the projects, and their riskiness, it is consistent with the findings of Koren and Tenreyro (2005). Recall from the introduction that Koren and Tenreyro (2005) finds that underdeveloped countries invest in highly risky projects, which contradicts the assumption made by Acemoglu and Zilibotti (1997), which is essential for their explanation of fluctuations. Note also that in our model, the economy is always on the steady-state, and therefore on a balanced growth path, i.e. fluctuations are not a consequence of departures from the steady-state.

In order to study how the expected growth rate of the economy due to vertical innovation, and its variance, is affected by the degree of industry diversification (the total number of industries J), we redefine equation (4.24) as follows

$$\begin{aligned} \frac{\Delta T_{s+1}}{T_s} &= \frac{\sum_{j=1}^J L_j(S_1)}{J}\frac{\sum_{j=1}^J J_j(c^*)}{J} p_H vI \\ &= \frac{\sum_{j=1}^J H_j(c^*, S_1)}{J} p_H vI, \end{aligned} \tag{4.25}$$

where $H_j(c^*, S_1) = L_j(S_1)J_j(c^*)$ is a new indicator variable for industry j that assumes the value 1 if $c_j \leq c^*$ and industry j is not liquidated by the intermediary, and 0 otherwise. Note that the expected value of $H_j(c^*, S_1)$, $E(H_j(c^*, S_1)|N)$, is equal to $Prob(H_j(c^*, S_1) = 1|N)$ for all j, which, as $Prob(L_j(S_1) = 1|N)$, has a negative relationship with $Prob(S_1 < 0|M)$ (see section 4.4). Therefore, $Prob(H_j(c^*, S_1) = 1|N)$ is a positive function of J, i.e. $Prob(H_j(c^*, S_1) = 1|N)$ is larger, the more diversified the economy is.

Using equation (4.25), the expected growth rate of the economy due to vertical innovation is

$$\begin{aligned} E(\frac{\Delta T_{s+1}}{T_s}|N) &= \frac{p_H v I}{J} \sum_{j=1}^{J} E(H_j(c^*, S_1)|N) \\ &= p_H v I Prob(H_j(c^*, S_1) = 1|N), \end{aligned} \tag{4.26}$$

where $N = \{\hat{S}_1 = 0\}$ means that partial liquidation has eliminated aggregate liquidity shortage, and $Prob(H_j(c^*, S_1) = 1|N)$ is increasing in the number of industries J. Therefore, $E(\frac{\Delta T_{s+1}}{T_s}|N)$ is also increasing in the number of industries J, i.e. the expected growth rate of the economy is higher when industry diversification is higher. The reason is that a higher industry diversification implies a higher probability that industry j is not liquidated by the intermediary due to a shortage of aggregate liquidity. Thus, a larger fraction of firms are able to finish successfully with their investment projects, and there is more vertical innovation in the economy.

In other words, economies that have higher industry diversification, have also deeper financial systems, and thus have a higher probability of being able to finance investment projects when there are shocks in the economy. The higher probability of successfully financing investment projects implies that more investment projects produce vertical innovation, and thus the expected growth rate of the economy is higher. The result that the expected growth rate is increasing with the degree of financial development is in line with the conclusions of Aghion et al. (2005) and Acemoglu and Zilibotti (1997). Note also that when the economy is perfectly diversified, and there is no aggregate liquidity shortage, the growth rate of the economy due to vertical innovation tends to the deterministic balanced-growth equilibrium

$$\text{plim}_{J\to\infty} \frac{\Delta T_{s+1}}{T_s} = F(c^*) p_H v I, \tag{4.27}$$

because $\delta_s F_s^J(c^*) \to F(c^*)$ as $J \to \infty$.

The variance of the growth rate of the economy is

$$
\begin{aligned}
Var(\frac{\Delta T_{s+1}}{T_s}|N) &= (p_H vI)^2 Var(\delta_s F_s^J(c^*)|N) \\
&= (\frac{p_H vI}{J})^2 \sum_{j=1}^{J} Var(H_j(c^*, S_1)|N) \\
&= \frac{(p_H vI)^2}{J} Prob(H_j(c^*, S_1) = 1|N)(1 - \\
&\quad Prob(H_j(c^*, S_1) = 1|N)), \qquad (4.28)
\end{aligned}
$$

where $Prob(H_j(c^*, S_1) = 1|N)(1 - Prob(H_j(c^*, S_1) = 1|N))$ is the variance of $H_j(c^*, S_1)$ for all j. From equation (4.28), there are two forces that have to be considered in order to analyze how the variance of the growth rate is related to the total number of industries J (or the degree of industry diversification). On one side, the variance of the growth rate is linearly decreasing in J due to the direct effect of J being in the denominator. On the other side, the variance of the growth rate is a quadratic concave function of J due to the effect of the variance of $H_j(c^*, S_1)$, which for lower values of J is increasing in J, and for higher values of J is decreasing in J. The reason is that $Prob(H_j(c^*, S_1) = 1|N)$ is increasing in J, and therefore the variance of $H_j(c^*, S_1)$, $Prob(H_j(c^*, S_1) = 1|N)(1 - Prob(H_j(c^*, S_1) = 1|N))$, is a quadratic concave function of J. When $Prob(H_j(c^*, S_1) = 1|N) < 0,5$, which is the case for lower values of J, the variance of $H_j(c^*, S_1)$ is increasing in J. However, when $Prob(H_j(c^*, S_1) = 1|N) > 0,5$, which is the case for higher values of J, it is decreasing in J.

The overall effect of the number of industries J (industry diversification) on the variance of the growth rate is that it is increasing in J for low levels of J, but strictly decreasing for higher levels of J. In other words, the variance of the growth rate is initially, for low levels of industry diversification (or financial development), increasing with industry diversification. For intermediate and high levels of industry diversification (or financial development), the variance is strictly decreasing with industry diversification. Figure 4.4 present a graphic example of the relationship between the variance of the growth rate of the economy and the total number of industries J (industry diversification). This ambiguous effect of financial development on the variance of the growth rate is in line with the results of Aghion et al. (2005), Acemoglu and Zilibotti (1997), and Carranza and Galdon-Sanchez (2004). Note also that when the economy is perfectly diversified, and there is no aggregate liquidity shortage, the variance of the growth rate of the economy due to vertical innovation tends to zero.

The growth rate of the number of industries J in the economy due to horizontal innovation is given by equation (4.2), which becomes

$$\frac{\Delta J_{s+1}}{J_s} = \delta_s F_s^J(c^*) p_H hI. \qquad (4.29)$$

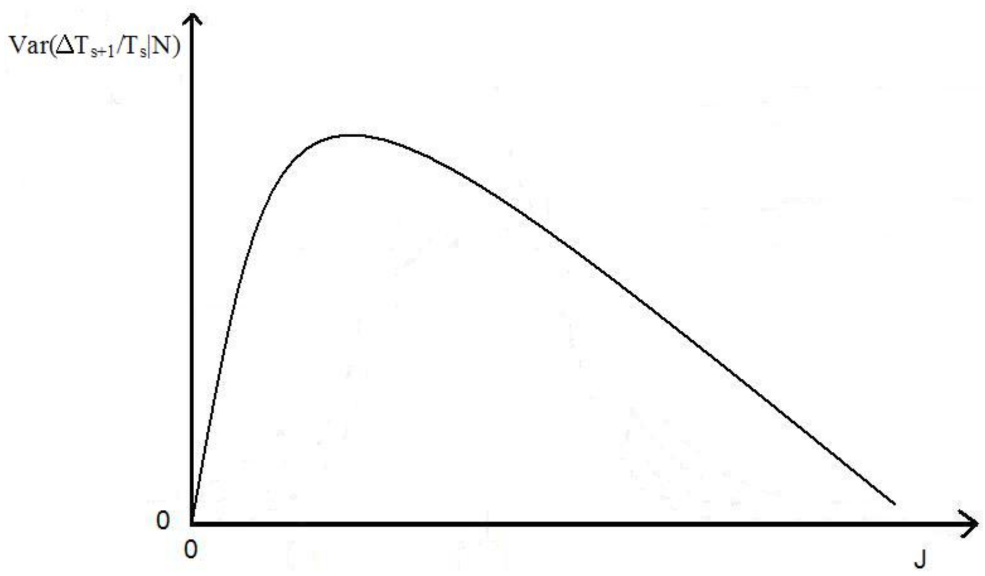

Figure 4.4: Variance of the growth rate of the economy

Combining equation (4.29) with the new indicator variable $H_j(c^*, S_1)$, as in equation (4.25), the expected growth rate of the number of industries J is

$$E(\frac{\Delta J_{s+1}}{J_s}|N) = \frac{p_H hI}{J}\sum_{j=1}^{J} E(H_j(c^*, S_1)|N)$$
$$= p_H hI Prob(H_j(c^*, S_1) = 1|N). \quad (4.30)$$

Clearly, an increase in $Prob(H_j(c^*, S_1) = 1|N)$, increases the growth rate of industries J, which makes the economy more diversified. Again, and as discussed in this section, $Prob(H_j(c^*, S_1) = 1|N)$ depends positively on J, which implies that economies that are more diversified have higher expected growth rate of industries J. The reason is that higher levels of industry diversification imply that the financial system is more developed, and have higher chances of successfully providing liquidity to firms when shocks occur. This, in turn, imply that more firms are able to complete their investment projects and produce horizontal innovation. Note also that when the economy is perfectly diversified, and there is no aggregate liquidity shortage, the growth rate of horizontal innovation tends to the deterministic balanced-growth equilibrium

$$\text{plim}_{J\to\infty}\frac{\Delta J_{s+1}}{J_s} = F(c^*)p_H hI, \quad (4.31)$$

because $\delta_s F_s^J(c^*) \to F(c^*)$ as $J \to \infty$.

From equation (4.30), it is clear that horizontal innovation has a reinforcing effect on itself. The reason is that the higher J is at present, the more horizontal innovation there will be in the future due to a higher $Prob(H_j(c^*, S_1) = 1|N)$. A higher $Prob(H_j(c^*, S_1) = 1|N)$, in turn, implies that J will have an even higher growth rate in the future. Thus, a high initial J imply that the growth rate of J in the future is higher than it would be if the initial J is low. Clearly, countries that are more diversified become even more diversified at higher speeds than countries that are less diversified. In other words, countries with initially high levels of industry diversification, and thus high levels of financial development, enjoy faster industry diversification and financial development than countries with initially low levels of industry diversification (and thus low levels of financial development).

The reinforcing effect of horizontal innovation does not only increase the future expected growth rate of horizontal innovation (industry diversification), but also increases the speed at which the financial system develops, i.e it improves the probability of the financial system to finance liquidity shocks. This effect on the financial system implies that horizontal innovation enhances, indirectly, the future growth rate of vertical innovation. This follows directly from the positive relationship between $Prob(H_j(c^*, S_1) = 1|N)$ and J, and equation (4.26). Thus, a high initial level of industry diversification does not only imply that current expected growth rates of vertical and horizontal innovation are higher than if the initial level of industry diversification was low, but also that the future expected growth rates of vertical and horizontal innovation will be even higher than the current ones. Note that although the expected growth rates of vertical and horizontal innovation tends to increase as the economy becomes more diversified, the expected growth rates tend to the balanced-growth equilibriums $\Delta T_{s+1}/T_s = F(c^*)p_H vI$ (equation (4.27)) and $\Delta J_{s+1}/J_s = F(c^*)p_H hI$ (equation (4.31)), respectively, which are the growth rates of a perfectly diversified economy.

In this model, horizontal innovation produces an externality through its reinforcing effect on itself, and its effects on the financial system. A high level of industry diversification implies that the current growth rate of the economy is higher, and less volatile, than it would be if industry diversification was low, but also that the future growth rates are going to be higher than the current one. This externality implies that current lucky countries, in terms of getting low liquidity shocks, and thus less aggregate liquidity shortage, will benefit even in the future by having higher, and less volatile, growth rates of the economy. Consider, for example, two countries that have the same level of industry diversification J. One of the countries, however, is more lucky than the other in terms of getting lower liquidity shocks for a number of periods. Then, the lucky country ends up having a higher, and less volatile, growth rate of the economy than the unlucky country even in the future. This result is in line with the theoretical model developed by Acemoglu and Zilibotti (1997).

Regarding government intervention, it is clear from the model that there is a role for the government to subsidize vertical and horizontal innovation. This result is in line with Aghion and Howitt (1998) and Howitt (1999) among others. In our model, a government subsidy means that the government provides additional liquidity to firms in period 1. Government intervention is especially relevant when there is an aggregate shortage of liquidity, i.e. when the intermediary cannot collect enough liquidity to finance all the profitable projects. As seen in section 4.4, an aggregate shortage of liquidity leads to partial liquidation. In this case, the provision of additional liquidity by the government in period 1 lowers the need for partial liquidation. Thus, the fraction of liquidated firms becomes lower than would be the case without intervention. Note that if there is no aggregate liquidity shortage, government intervention does not lead to a better outcome relative to the pure market outcome. Holmström and Tirole (1998) analyzes thoroughly the demand for and supply of government-supplied liquidity when there is a shortage of aggregate liquidity.

The reason that the government can provide additional liquidity, when the intermediary is unable to obtain this liquidity, is that the government can use its future tax revenues as collateral (see for example Holmström and Tirole (1998)). The intermediary can only collect liquidity if it has an asset to put as collateral. In our model, this was the case when the value of the investment portfolio S_1 is positive. The government, instead, can always commit future tax revenues because it has the legal right to collect taxes, and can physically punish (jail, bankruptcy, etc) those that do not pay taxes.

The consequence of government intervention, when there is an aggregate shortage of liquidity, is that a lower fraction of firms are liquidated, and more investment projects are completed. This means that a government subsidy to vertical innovation implies a higher growth rate of the economy. Moreover, a subsidy to vertical innovation in this setting reduces the fluctuation of the growth rate across generations s. Thus, subsidies to vertical innovation can be used as a policy instrument in a stabilization strategy. A subsidy to horizontal innovation produces a higher industry diversification than the pure market outcome. Further, through the effect of industry diversification on the financial system, a horizontal subsidy leads to higher, and less volatile, growth rates of the economy in the future. Thus, subsidies to horizontal innovation can be used as a policy instrument to avoid future fluctuations in the economy. Due to the externality produced by industry diversification, subsidizing horizontal innovation is particularly beneficial for countries at initial and intermediate stages of financial development compared with subsidizing vertical innovation. The reason is that a subsidy to horizontal innovation increases permanently the expected growth rate of the economy through its effect on the financial system. In contrast, a subsidy to vertical innovation produces only a temporary increase in the growth rate of the economy. Note also that government intervention is especially suited for countries at initial and intermediate stages of financial development because in these stages there is a larger probability of getting an aggregate shortage of liquidity.

4.6 Conclusions

This paper presents a theoretical model where the financial system develops endogenously and has a central role in determining the growth rate of the economy, and its volatility. In the model, the productive sector is engaged in both vertical and horizontal innovation, but has to finance liquidity shocks for these innovations to be successful. Economic growth is determined by vertical innovation, which improves the quality of already existing goods. Horizontal innovation, on the other hand, does not affect economic growth directly, but produces new goods, which increases industry diversification. Industry diversification deepens the financial system because it improves the probability of the financial system in providing liquidity to the productive sector. Fluctuations across time arise because the fraction of firms fulfilling their investment projects at each period of time varies. The financial system has two key attributes that makes it especially suited for providing liquidity to the productive sector. The first is its ability to pool firms' risks, and the second is its ability to exercise partial liquidation at the industry level.

The main results of this paper are summarized as follows. Industry diversification is the main factor behind financial development. Thus, horizontal innovation has a central role in explaining financial development as part of the growth process. The expected growth rate of the economy due to vertical innovation is positively related to the level of industry diversification, and thus to the level of financial development. The volatility of the growth rate of the economy is initially increasing with the level of industry diversification, but becomes decreasing at intermediate and high stages of industry diversification. The growth rate of industry diversification due to horizontal innovation is positively associated with the level of industry diversification, and thus to the level of financial development. Industry diversification produces an externality through its effect on the financial system in the sense that a high initial level of industry diversification does not only imply high current growth rates of the economy and industry diversification, but also increasing growth rates in the future due to a deeper financial system. The implication of this externality is that, given the same initial level of industry diversification and financial development, current lucky countries, in terms of getting low liquidity shocks, benefit even in the future by having higher growth rates than the unlucky countries.

In this model, there is a role for the government to subsidize vertical and horizontal innovation when the financial system is unable to provide liquidity to all firms. Government subsidies to vertical innovation lead to a higher growth rate of the economy than would be possible without government intervention. They also mitigate fluctuations in the growth rate across time, serving as a policy instrument in a stabilization strategy. Subsidies to horizontal innovation entail a higher industry diversification, and thus financial development. Thus, they lead to higher, and less volatile, growth rates of the economy in the future. They may be used as policy instruments to avoid future fluctuations in the economy. Due to the externality generated by industry diversification on the financial system, subsidizing horizontal innovation, in contrast to vertical innovation, is particularly beneficial for countries at initial and intermediate stages of industry diversification and financial development. Furthermore, government intervention is especially suited for countries at initial and intermediate stages of financial development because in these stages there is a larger probability of getting an aggregate shortage of liquidity.

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Appendix

4.A1 Proof of equivalence of equations (4.6) and (4.9)

From equation (4.6), we have that

$$U_b = \frac{F(c^*)p_H R - 1 - \int_0^{c^*} cf(c)dc}{1 + \int_0^{c^*} cf(c)dc - F(c^*)c_p} A.$$

Multiplying equation (4.6) by $F(c^*)/F(c^*)$ and rearranging, we get

$$U_b = \frac{p_H R - \frac{1+\int_0^{c^*} cf(c)dc}{F(c^*)}}{\frac{1+\int_0^{c^*} cf(c)dc}{F(c^*)} - c_p} A. \tag{4.32}$$

Maximizing equation (4.32) is clearly equivalent to minimizing

$$c(c^*) = \frac{1 + \int_0^{c^*} cf(c)dc}{F(c^*)}, \tag{4.33}$$

which is the expected unit cost of effective investment. Moreover, if equation (4.33) is integrated by parts, we obtain

$$\begin{aligned} c(c^*) &= \frac{1 + c^* F(c^*) - \int_0^{c^*} F(c)dc}{F(c^*)} \\ &= c^* + \frac{1 - \int_0^{c^*} F(c)dc}{F(c^*)}, \end{aligned}$$

which is what is minimized in equation (4.9). Q.E.D.

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