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Abstract

Recent research has shown that there is significant cross-country heterogeneity in the previously well-established relationship of finance and long-run growth. We explore this heterogeneity by estimating finite mixture models and by considering the effects of foreign and domestic lending separately. We find that bank lending does not have the same effect on growth or savings in all countries. Country characteristics such as the extent of stock market development, the degree of rule of law, and even the development of the banking sector itself vary considerably across countries and affect the productivity of bank lending in encouraging growth and savings. Furthermore, the effect of bank finance on growth and the effect of foreign bank involvement depend on 1) how well developed the banking sector is, and 2) if foreign banks are involved via loans made by affiliates located within the country or via cross-border loans. The experience of lenders with a presence in the country is important, but only once a threshold level of financial sector development is reached. In countries with underdeveloped banking sectors, the influence of foreign-owned lenders relative to locally-owned banks can be detrimental to growth.

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1 Introduction

One of the few empirically and theoretically robust results in the growth literature is the importance of investment in generating sustained, long-run growth of real income per capita (see King and Levine 1993). A strand of this literature has focused on the effects of financial (stock market) development and bank financing on growth and on savings as a fundamental determinant of growth (Levine and Zervos 1998). We contribute to this literature, extending it in two directions. First, we provide a more careful examination of the effects of bank credit on growth and savings by looking separately at (1) local bank loans versus foreign bank lending, and (2) domestic (affiliate) versus cross-border lending.[1] Second, we allow for the effects of bank credit to vary among the countries by estimating finite mixture models. Overall, we find that the effect of bank credit on growth and savings does vary across groups of countries. Furthermore, the source of bank credit (local or foreign institutions) is also an important determinant of the effect of bank loans on both savings and growth and this effect varies across groups of countries as well.

Our paper addresses several puzzles that remain in the growth-finance research. The first and most important issue is that there is detectable and significant cross-country heterogeneity in the relationship between bank lending and growth as well as bank lending and savings. This heterogeneity appears both as overall cross-country differences (Demetriades and Hussein 1996), and also as non-linearities over different levels of financial development (Rioja and Valev 2004) and macro indicators (Rousseau and Wachtel 2002; Yilmazkuday 2011). Our main contribution is that we estimate finite mixture models in order to address heterogeneity in the growth process. Our approach allows us to group countries based on the conditional distribution of growth or savings rates. Although we explain our methods in more detail below, essentially we classify countries as belonging to the same group if they have the same conditional distribution of growth rates, or in other words, the same coefficients in the growth regression. Because we classify countries by the conditional distribution of growth rates

[1] In what follows, "domestic" refers to banks operating within the borders of the host country, irrespective of their nationality. The term "local", on the other hand, refers to banks which are headquartered in the given host country.

(conditional on the independent variables in the regression equation and additional predictor variables), one interpretation of our findings is that the growth processes are similar within the group.

The finite mixture model allows the data itself to determine class membership. In this, it is preferable to the previously used rolling regression models in which researchers impose the sorting variables (inflation, etc.) *a priori*. This endogenous sorting may be particularly important in dissecting the relationship between growth, savings and financial intermediary development if growth and private savings rates are also affected by unobserved country characteristics (e.g., culture). Our focus on conditional distributions incorporates additional characteristics that help to explain the groupings. In this, we extend previous papers in the growth literature that examined the unconditional distribution of growth rates (Bloom et al. 2003, Paap et al. 2005), or did not use additional explanatory factors to predict groupings (Alfo et al. 2008).[2] Our estimation results validate our specification by showing strong evidence of heterogeneity in the effect of bank lending on growth and savings during the time period 1995 to 2010. The finite mixture model categorizes countries into one of two separate groups based on the effects of bank lending on growth.

Our use of the finite mixture method is a powerful way to account for cross-country heterogeneity. However, we would also like to understand how the *composition* of bank lending affects the growth impact of finance in a given country. Therefore, we go beyond the previous literature's use of aggregate credit measures by differentiating loans based on the originating bank's nationality (foreign vs. local) and type (cross-border vs. affiliate). We have many reasons to believe that bank nationality is an important distinction for growth, since foreign banks tend to promote technology transfer (Goldberg 2004) and domestic banking sector competition (Mishkin 2007), which – if market uncertainty is low – will then lead to higher capital accumulation, economic growth (Cetorelli and Peretto 2012) and improved efficiency (Claessens et al. 2001). By promoting more sophisticated risk management practices (Mishkin

[2] The most closely related methods to those we use in this study are those found in Owen et al. (2009) who not only examine the conditional distribution of long-run growth rates using panel data, but also explore country characteristics that help to explain the groupings. The focus in Owen et al. (2009), however, is different from ours because they do not examine the effect of bank finance in that context. See also Bos et al. (2010).

2003) and providing a local safe haven for capital, foreign banks may also reduce the probability of a banking crisis (Demirguc-Kunt et al. 1998).

An alternative, but equally important dimension along which we differentiate bank lending is type: whether credit is originated from abroad via cross-border lending, or domestically via affiliates. We have compelling reasons to believe that the relative growth effect of foreign bank activity might vary by type (cross-border loans vs. affiliate lending). Actual physical entry of foreign banks provides many growth advantages over the more volatile cross-border lending (Cetorelli and Goldberg 2011): a broader array of financial services (Clarke et al. 2001), efficiency improvement (Peria and Schmukler 2001) and stability (Goldberg 2004) – especially if the affiliate is an important source of revenue for the global parent bank (Cetorelli and Goldberg 2012). A further reason we must differentiate by loan type is that cross-border lending and affiliate lending fuel very different sectors of the economy. The former tends to go to banks and large private borrowers[3], while the latter is aimed more at private retail customers (Temesvary 2011). Our estimation results show that the role that bank nationality and type play in the growth process varies significantly across the two groups of countries our finite mixture model identifies. In one group, our results highlight the importance of the expertise of domestic lenders that are located within the country, irrespective of their nationality. In the second group, however, the influence of foreign lenders relative to local lenders is paramount.

Beyond heterogeneity, a second important issue to address is that the finance-growth relationship seems to have weakened over time (Rousseau and Wachtel 2011). This result is confirmed by our preliminary cross-country regression analysis, in which we replicate the Levine and Zervos (1998) regressions for the time period 1995-2010. A third important issue we tackle in this paper is that the channel through which financial intermediary development affects growth remains unclear. While the impact on total factor productivity appears important as a channel (Beck et al. 2000), the results on the impact of bank finance on saving are mixed (Levine and Zervos 1998; Rajan and Zingales 1998). We contribute by using the finite mixture method to sort countries into classes based on the relationships

[3] Following multinational corporations into new markets, for instance.

between bank lending and savings, i.e. to allow the data to tell us the ways in which the various types of bank lending are associated with higher savings rates. Our estimation results identify four groups of countries with distinct processes for determining the domestic savings rate. In each of these groups, the relative importance of foreign bank influence varies.

Our results are developed in the following four sections. In the next section, we briefly describe the data and variables we use and then, in Section 3, present some preliminary cross-section results that are comparable to previous literature. As will become evident, our preliminary results strongly support the conclusion that the effect of bank lending varies by country characteristic. To better account for the heterogeneity of the effects, we then use a more appropriate empirical technique. We estimate finite mixture models that allow us to group countries based on the conditional distribution of growth rates and savings rates, so that we can examine the effects of bank finance within these groupings. We explain the details of the econometric technique in Section 4 and the results of our finite mixture estimations in Section 5.

2 Data

There is substantial evidence that total credit as a share of GDP is an important determinant of growth (Levine and Zervos 1998). We also include a total credit to GDP variable in our analysis, with two important modifications. First, we have excluded central bank lending from total credit, because our goal is to focus on private credit exclusively. Second, our variable includes cross-border loans because they also provide financial liquidity to host market countries.[4] We name our total bank lending-GDP ratio *BANK*.

An important contribution of our analysis is that we examine how the growth effects of bank lending depend on the nationality of lender, and the "type" of bank loans. As described above, *local*

[4] Cross-border loans include all loans to local borrowers from abroad, including loans to local banks. We also experimented with a measure of cross-border loans that excluded cross-border loans to banks, guided by the observation that some local banks re-lend these funds in the form of domestic loans. This alternative measure of cross-border lending is highly correlated with the original measure (correlation coefficient of .91) and although using this narrower definition of cross-border loans resulted in a smaller sample, we essentially draw the same major conclusions. We report as our main results the estimations with the larger sample. The additional results are available from the authors upon request.

lending refers to loans originated by banks who are residents of the host country. *Domestic* lending, on the other hand, refers to loans which come from banks within the borders of the host country – irrespective of whether the bank is owned by residents, or if it is an affiliate of a foreign-owned bank. Based on these definitions, we define the variable *FOREIGN-LOCAL* as the stock of total claims by foreign banks (cross-border loans plus foreign affiliate loans) on host country private borrowers, divided by the stock of claims by local banks on private local borrowers. This variable is designed to capture the prevalence of foreign credit in funding host country borrowers. Similarly, the variable *DOMESTIC-CB* is the stock of claims by domestic banks (domestic affiliates of foreign banks plus local banks) divided by the stock of cross-border claims from foreign banks. This variable captures the prevalence of loans provided within the borders of the country relative to bank credit from abroad.[5]

Data on bank claims come from various sources. Data on foreign banks' cross-border and affiliate lending (including both local and foreign currency lending) are derived from the BIS's Consolidated Banking Statistics: Items 9A and 9C. All data are on an Immediate Counterparty basis. As a result, we have made no adjustments for cross-border derivatives and risk transfers. Data on total domestic bank credit are derived from the IMF's International Financial Statistics (IFS)' Depository Corp. and Other Depository Corp. Survey: Non-standardized Presentation. Finally, local bank loans is measured as total domestic (non-central bank) bank credit minus foreign banks' affiliate lending in the given host country. Data on all other variables come from the IMF's International Financial Statistics or World Bank data sets. The stock market variables have been appended with data from Demirguc-Kunt and Levine (2001). A common issue in the finance and growth literature is that of simultaneity in the co-evolution of financial depth and economic growth. In order to ensure that simultaneous determination (or even, reverse causation) is not an issue in our analysis, we use initial values of the finance variables in all our estimations. Table 1 provides data definitions, sources, and descriptive statistics for both our cross-section and panel data sets.

[5] The ratios that describe foreign vs. domestic bank activity are not simply proxies for total bank lending. In our panel data set, the correlation between BANK and FOREIGN-LOCAL is weak (.10) and the correlation between DOMESTIC-CB and BANK is actually negative (-.10).

3 Preliminary Cross-Section Results

We start with a preliminary analysis exploring the relationship between financial development and growth and financial development and savings in cross-section regressions that are similar to those in Levine and Zervos (1998). We also include similar control variables in all estimations: the log of initial income, average secondary school enrollment rate, average inflation rates, rule of law, average government consumption/GDP and the average of (exports+imports)/GDP. However, our specification contains some important modifications which can make our results different in a meaningful way. One is that we examine a later time period (1995 to 2010), a potentially important difference given Rousseau and Wachtel (2011)'s finding of a weaking finance-growth relationship over time. Our bank credit-related explanatory variables are also new, as defined above.

Our initial results from this cross-section estimation appear in Table 2. In the first three columns of Table 2, we present cross-country results for per capita GDP growth. The specification in the first column is most directly comparable to that in Levine and Zervos (1998) and is restricted to countries that were in their original sample. In column two, we present the same specification; however, we have a considerably larger sample because more data are available for the later time period that we examine. Nonetheless, the results in columns 1 and 2 are qualitatively similar. Our results confirm the weakening finance-growth relationship over time.

The *FOREIGN-LOCAL* and *DOMESTIC-CB* ratios are included in the expanded specification of the cross-section regression. In the Introduction (Section 1), we have outlined numerous established arguments as to why the composition (nationality and type) of credit matters for growth and savings. A natural implication of these arguments is that the impact of our overall credit variable should depend on its composition as well. In the growth regressions, nationality matters in that relatively more credit from foreign lenders may bring knowledge and experience, and loan covenants on foreign lending could improve management and efficiency of the use of bank credit. Furthermore, type matters in that domestic lenders might have better knowledge of local conditions and quality of management than banks lending via cross-border loans, giving them an advantage in making productive loans. These differences can

significantly influence the marginal impact of total lending on growth.[6] When considering the effects of foreign banks on savings, similar advantages and disadvantages are apparent. Foreign banks may offer better financial products to facilitate savings, but the domestic presence of banks may lower the transaction costs of savings considerably. Alternatively, the marginal impact of credit composition (nationality and type) on growth and savings can depend on the overall financial development of the country (total lending). Therefore, in addition to examining the finance and growth relationship in a different time period, we also capture the role of credit composition by interacting total bank lending, *BANK*, with *FOREIGN-LOCAL* and *DOMESTIC-CB*.

In column 3 of Table 2, we present results for this expanded specification. While the coefficient on total bank lending remains negative and is now significant, when we interpret this in conjunction with the interaction terms, we conclude that for countries with average amounts of foreign bank activity (the two ratios at the sample average), the marginal effect of total bank lending on per capita GDP growth is positive. It is only countries that have significantly below-average relative foreign bank lending and amounts of domestic lending relative to cross-border lending for which the marginal effect of additional bank lending is negative.

We draw similar conclusions for the impact of bank lending on savings rates. The baseline results reported in columns 4 through 6 of Table 1 show that when we do not include measures of foreign bank involvement, there is little evidence that financial development, as measured by total bank lending, influences savings. However, when we include measures that account for the involvement of foreign banks in the expanded specification, we find that for the country with average amounts of foreign bank activity (the ratios at the sample average), the marginal effect of total bank lending on the domestic savings rate is positive. Furthermore, as expected, for a country with an average amount of total bank lending, the effect on savings of a greater *DOMESTIC-CB* is positive. This finding is consistent with the hypothesis that a domestic presence facilitates savings by lowering transaction costs.

[6] These effects might be especially important in developing countries.

This preliminary investigation has shown that the effects of financial development as measured by bank lending depend on the composition of credit, especially the extent of foreign bank activity. This suggests that there is heterogeneity in the effects of bank credit. In the next section, we propose a more appropriate way to account for this heterogeneity, and we present the corresponding results.

4 Finite Mixture Models

As highlighted in the introduction, finite mixture models are becoming an increasingly popular means of modeling heterogeneity in the economics literature. Essentially, these models assume that the distribution of outcomes that we observe is the result of a mixture of a finite number of distributions that are not observed directly. In our case, we are interested in modeling the conditional distribution of growth rates and savings rates (conditional on the independent variables in the regression model and additional predictor variables.) As we explain further below, each country is assigned to a group (or latent class) based on the conditional distribution of growth rates or savings rates. For each class, separate regression coefficients are estimated and statistical tests are performed to identify meaningful differences across the groups. One advantage of this technique is that the regression parameters and probabilities of class membership for each country are estimated simultaneously via maximum likelihood.

Conceptually, this approach has several advantages to the standard regression approach. Most importantly, it allows us to model heterogeneity without making ad hoc assumptions about the way in which the heterogeneity manifests itself (e.g., via country fixed effects, or groupings imposed *a priori* by the researcher).[7] Another important advantage is that it allows us to choose to model variables that are typically used as "control variables" in a regression either as variables that enter the regression and influence the dependent variable directly or as variables that simply influence the groupings of countries. In other words, the role of a typical "control" variable may simply be one of determining the probability that a country is in a particular group. For example, in our preliminary cross-section estimation of per capita GDP growth, consistent with previous literature, we have included several control variables that

[7] Country fixed-effects allow only for intercept heterogeneity. Finite mixture models allow for heterogeneity in both the slopes and intercepts.

arguably are not directly related to growth, but may affect the way in which bank credit affects growth. Specifically, it is more consistent with current growth theory to think of policy variables such as inflation, government spending, trade, and rule of law as variables that do not directly impact growth, but rather influence the environment in which growth occurs. Therefore, we use these variables to help predict the groupings, but not as direct determinants of growth or savings in the regressions. In other words, they influence the effect of bank lending on growth, but we do not model these variables as a proximate cause of growth. In contrast, the theory of a human capital-augmented Solow model tells us that both initial income and human capital are proximate causes of growth and should be included as independent variables in a growth regression. Likewise, we include various measures of bank credit because of their close links to investment in the growth regression. This treatment of the proximate causes of growth vs. variables that influence the environment in which growth occurs follows that of Owen et al. (2009) who estimate finite mixture models for growth regressions.

That said, the appropriate specification for stock market capitalization is less clear cut. The result that stock market capitalization is insignificant once we control for bank credit (Levine and Zervos 1998) is in line with the logic that equity and debt are alternative forms of financing for firms. As a result, (i) debt financing may be particularly productive in countries with under-developed stock markets, and (ii) the effect of bank lending is smaller in countries with high stock market capitalization. The Levine and Zervos (1998) result then suggests that stock market capitalization should be considered as a predictor variable that influences the manner in which bank lending affects growth rather than as a variable that directly affects growth. Fortunately, as we explain below, we are able to statistically test this treatment of stock market capitalization in our estimations. We use the same econometric specification for growth and savings rates, described more formally below.

The fifteen-year time period from 1995 to 2010 allows us to maximize observations for the preliminary cross-section estimations that are most comparable to earlier results. However, because the estimation of finite mixture models is a data-intensive process, we expand the time frame back to 1985 and examine an unbalanced panel with observations every five years. This strategy yields a significantly

larger sample, with 82 countries and 299 observations. As will become clear in what follows, although we use panel data, we do not estimate country-specific effects. Rather, our strategy for dealing with country heterogeneity is to allow all the regression parameters (including the constant term) to vary based on the groupings identified in the data. If the model that best fits the data is one in which each country has different regression parameters, then our methods would reveal that there are as many separate classes as there are countries. We do not find this to be the case. However, we do restrict countries to belong to the same grouping for the entire time period of 1985 to 2010. Because of this, we allow for time heterogeneity by including time dummies for each five-year group.[8]

To characterize the econometric model more formally, we assume that conditional distributions can be classified into *M* discrete classes which are not directly observed.[9] Let *T* represent the number of repeated observations per country, **z** be the vector of independent variables in the regression, **v** be the vector of *K* class membership predictors, and let *j* indicate the latent class. Then, the probability structure for a given country is:

$$f(g_t \mid \mathbf{z}_t, \mathbf{v}) = \sum_{j=1}^{M} \pi_j(\mathbf{v}) \prod_{t=1}^{T} f(g_t \mid j, \mathbf{z}_t).$$

where $f(g_t \mid j, \mathbf{z}_t)$ is the distribution of growth rates or savings rates conditional on membership in latent class *j* and independent variables, and $f(g_t \mid \mathbf{z}_t, \mathbf{v})$ is the distribution of growth rates or savings rates conditional on independent variables and the vector o f class predictor variables, **v**. The probability of membership in latent class *m* (i.e., probability that *j*=*m*), given the predictor variables, **v**, is defined with a multinomial logit model. Specifically,

[8] It is theoretically possible to estimate a Markov switching model in which countries can switch classes over time. However, the data requirements of such estimation are more extensive and given data limitations, we do not have sufficient variation over time in order to estimate a model in which there is evidence that any countries switch classes during the time period we observe.

[9] Interested readers should also see Owen et al. (2009), and Skrondal and Rabe-Hesketh (2004) for a more detailed discussion of finite mixture model estimation.

$$\pi_m(\mathbf{v}) = \frac{\exp(\gamma_{m,0} + \sum_{k=1}^{K} \gamma_{m,k} v_k)}{1 + \exp(\gamma_{1,0} + \sum_{k=1}^{K} \gamma_{1,k} v_k) + \exp(\gamma_{2,0} + \sum_{k=1}^{K} \gamma_{2,k} v_k) + ... + \exp(\gamma_{(M-1),0} + \sum_{k=1}^{K} \gamma_{(M-1),k} v_k)}.$$

Intuitively, these methods allow us to improve the groupings of countries by including country characteristics that do not influence growth or savings directly, but may influence them indirectly by determining the impact of the independent variables in the regressions. For example, a variable measuring the degree of rule of law may influence the environment in which growth occurs and therefore determine the impact of bank credit on growth, but is not either a measure of factor accumulation or technology so does not directly affect growth. The vector, **v**, contains the predictor variables that we use in our estimations: rule of law, inflation, government consumption, openness to trade, and stock market capitalization. We also add a predictor variable not used by Levine and Zervos (1998): whether or not a country is classified as a banking center by the Federal Financial Institutions Examination Council.[10]

We can calculate the country-specific posterior membership probabilities for each country i = 1,…,N using the empirical Bayes rule. The probability that country i belongs to class m is:

$$\hat{\pi}(m \mid \mathbf{v}_i, g_i) = \frac{\pi_m(\mathbf{v}_i) f(g_i \mid m, \mathbf{z}_i)}{\sum_{j=1}^{M} \pi_j(\mathbf{v}_i) f(g_i \mid j, \mathbf{z}_i)}$$

Once we calculate the probability of class membership for each country, we use the empirical Bayes modal classification rule to assign countries into classes; we assign each country to the class for which it has the largest posterior probability. Although for most countries the classification occurs with posterior probabilities very close to 1, the classification is probabilistic. Classification errors are likely to be higher when the largest posterior probability is low. Specifically, the conditional probability of

[10] Because we do not allow countries to switch classes over time, the predictor variables must be constant over the entire sample. We choose values early in the sample period to avoid the problem that these variables are correlated with the error in the growth regressions. However, because we have an unbalanced panel with fewer observations in the earlier time periods, we choose 1995 values for all our predictor variables except for rule of law for which we choose the value in 2005. These choices reflect a tradeoff between choosing values that are earlier in the sample period vs. maximizing the sample size.

misclassification for a given country is $1-\max\hat{\pi}(j\mid \mathbf{v}_i, g_i)$ and the overall misclassification error for the model is $E=\frac{\sum_{i=1}^{N}1-\max\hat{\pi}(j\mid \mathbf{v}_i, g_i)}{N}$.

The overall misclassification rate can be used to judge the appropriateness of the model, holding the number of classes constant. However, as the number of classes increases, the largest posterior probability can decrease as more options for class membership become available, making it difficult to use the criteria to compare models with different numbers of classes.

Because the number of classes is unknown, we start with a one-class model and then estimate subsequent models that increase the number of classes by one each time. We use the Bayesian Information Criterion (BIC) to select the model that best fits the data. The BIC= -2LL + log(N)J where *LL* is the value of the log likelihood, N is the sample size, and *J* is the number of parameters estimated. The BIC is decreasing in the value of the log likelihood and increasing in the number of parameters estimated. Therefore, we choose the model with the lowest BIC. The likelihood functions for these types of models can feature local maxima; to ensure that we obtain the global maximum, we estimate each model using 10,000 sets of starting values.[11]

5 Finite Mixture Results

Growth Regressions

We start by examining a finite mixture model for growth regressions. Table 3 presents some fit statistics for models of one to five classes. As can be seen in this table, the model with the lowest BIC contains two classes. It has a significantly higher R^2 than the one class regression model and a relatively low classification error of .016. Of course, as we allow for more classes, the R^2 increases, but that comes at the cost of additional parameters to be estimated and therefore the BIC does not also continue to decrease as well.

[11] We use Latent GOLD to perform the estimation.

Table 4 presents descriptive statistics for the countries in each group, presenting median values of key characteristics to generate a profile of the classes. As can be seen in this table, Class 1 is slightly bigger than Class 2, with 57 percent of the observations in it. The median GDP growth rate is similar, but slightly higher for Class 2 countries, which also have significantly higher levels of initial income. As to be expected in a group of higher income countries, Class 2 countries also have higher levels of schooling and higher levels of rule of law, openness to trade, stock market capitalization, government expenditures, and lower inflation. None of the Class 2 countries are classified as a banking center, while four percent of the Class 1 countries are. An examination of the patterns of bank lending reveal that the Class 2 countries have higher median levels of total bank lending relative to GDP, a higher ratio of foreign to local lending, but a lower ratio of lending done by banks within the country relative to cross border lending. Based on these observations, we note that Class 2 countries may be considered generally more developed, however, we note that with higher levels of economic development, there appears to be a greater presence of foreign banks in the typical country in this class.

Country groupings in Table 5 are somewhat expected, but not completely anticipated *a priori*. It is important to emphasize that the model lets the data determine the groupings based on the conditional distribution of growth rates and the predictors, which is consistent with substantial heterogeneity of observable characteristics within the two groups of countries in Table 5. That is why we can have Botswana, Canada, China, and the Czech Republic belong to the same group, a grouping that most traditional means of classifying countries in growth analyses would not generate. Probabilities of group membership are also shown in Table 5, indicating that some countries are classified with greater certainty than others. For example, Italy belongs to its group with 85% probability, but China belongs to its group with a probability near one.

The top rows of Table 6 present the regression coefficients for the two classes. A quick examination reveals that the coefficients are different from each other in meaningful ways and the p-values for Wald tests of differences in the coefficients appear in the last column. The differences in the coefficients on all of the bank lending variables are significant or near significant at the 10 percent level.

The top half of Table 6 also reports additional diagnostic statistics. First, the R^2 for each group is reported; they indicate that the variation in the Class 2 countries is better explained by these independent variables than the variation in the Class 1 countries. In addition, the error variances for each regression are also reported along with their standard errors that indicate that we can reject the hypothesis that these variances are actually zero. This is important in this context because the likelihood functions for finite mixture models can often be complex. These non-zero variances ensure that we have not identified the maximum at a singularity in the conditional distribution.

Focusing on the coefficients of the regression models, we see that the most pronounced cross-class differences are in the effect of the *DOMESTIC-CB* ratio and its interaction with total bank lending. The results in Table 6 suggest that, for countries in Class 1, a greater domestic presence of banks (either affiliates of foreign banks or local lenders) actually has a negative effect on growth. However, in Class 2 (generally more developed countries), for the typical country that has a value of total bank lending either at or above the median value for the group, a greater domestic presence of banks has a positive marginal impact on growth of GDP per capita. These Class 2 countries have more expansive bank lending and the interaction of total bank lending and the *DOMESTIC-CB* ratio is positive in this group. Therefore we can conclude that more domestic lending relative to cross-border credit enhances the finance-growth nexus -- but only after a certain threshold level of intermediary development is achieved.[12]

The mitigating effects of a more developed banking sector overall on the impact of foreign bank lending is also seen in the results. The interaction of the *FOREIGN-LOCAL* ratio and total bank lending is positive in the regression for Class 1 countries. The magnitude of the coefficient on the interaction term is not large enough to totally offset the negative effect of the coefficient on *FOREIGN-LOCAL*. In general, this result shows that the negative impact of a relatively foreign-dominated banking sector is less severe at higher values of total bank credit. Consistent with this conclusion, we observe that in Class 2,

[12] This threshold result in conceptually similar to the findings of Borensztein (1998) and Alfaro et al. (2004) who investigage the FDI-growth relationship.

where countries have more developed banking sectors overall, the coefficient on *FOREIGN-LOCAL* is insignificant.

What is it that countries in each class have in common that determine these groupings? As mentioned above, the countries are grouped based on the conditional distribution of growth rates, not a directly observable country characteristic. However, the coefficients on the predictor variables that appear in the bottom rows of Table 6 can help to shed light on observable country characteristics that influence the groupings. For example, the positive and significant coefficient on rule of law suggests that higher values of rule of law are associated with a country being placed in the more developed group in which bank finance has a positive effect on growth. This result makes sense if stronger rule of law allows banks to operate more efficiently and effectively. The only other significant predictor is stock market capitalization, with lower values of capitalization being associated with a higher probability of being in Class 2. Since this is the group where domestic bank finance has a positive effect on growth, our results suggest that bank finance and stock market finance can be substitutes in promoting growth.[13] In general, the results for the predictor variables indicate that in countries with a stronger rule of law but also less developed stock markets, bank finance has a more positive effect on growth.

Our results suggest that the effect of bank finance on growth and the effect of foreign bank involvement depend on the degree of development of the banking sector. In countries with a more developed banking sector, domestic lenders have a greater positive impact and the effect of foreign influence is insignificant. In countries that have less developed banking sectors, on the other hand, the influence of foreign lenders relative to local lenders is more detrimental to growth. These results are consistent with a learning-by-doing theory in which (1) more experience with lending makes domestic banking more efficient, and that (2) when the domestic banking sector is less developed, a strong foreign influence can interfere with the accumulation of knowledge that makes domestic lending productive.

[13] While it may seem counterintuitive that more capitalized stock markets are associated with a lower probability of Class 2 membership given that this group contains most of the more developed countries with more capitalized stock markets, it is important to note that these coefficients can only be interpreted holding all the other variables in the estimation constant.

Savings Regressions

We turn now to analyzing the results of finite mixture models that examine the determination of savings rates. We proceed as above, except now the dependent variable of interest is average savings rates over the five year periods. Table 7 provides the fit statistics for models of one to five classes. The lowest BIC is for the four class model and we focus our analysis on this model. The larger number of classes for savings regressions is consistent with greater heterogeneity in unobserved country characteristics that influence the savings process, possibly because of cultural factors.

Profiles for each of the four classes appear in Table 8. Class 1 is the largest class, with 48 percent of the sample. The median value for the savings rate for countries in this group is the second highest at close to 22 percent of GDP. It also has intermediate values for most of the other country characteristics, including median income levels, schooling and several of the lending variables. Four percent of the observations in Class 1 are associated with a banking center country. Based on average country characteristics, Class 1 can be generally classified as the group of *High Saving – Low Financial Development* countries. Class 2 is the second largest class, with 21 percent of the sample. The median savings rate for countries in this group is considerably lower than that of Class 1 at 15 percent. Other characteristics such as income, schooling and the bank lending variables are comparable to Class 1, except that the median stock market capitalization in this group is significantly lower than for the other three groups. These countries might be generally characterized as *Low Saving – Low Financial Development* countries. In Class 3, the median country has a significantly higher savings rate than other countries, but also lower income and levels of schooling. It has the smallest *FOREIGN-LOCAL* ratio and also has the lowest value for openness to trade. In contrast to Class 2, however, the median country in this group has a relatively high stock market capitalization/GDP at 33 percent. Therefore, we can characterize this group as *High Saving – Medium Financial Development* countries. Finally, an examination of the Class 4 profile shows that the savings rate in the median country in Class 4 is the lowest of all the classes, at just shy of 13 percent. All other development indicators are relatively high, with the median country in Class 4 having the highest per capita income level, highest schooling, and the

total bank lending-GDP ratio. We can characterize this group as the *Low Saving – High Financial Development* countries.

As before, there is substantial heterogeneity in country characteristics in each of the groups. Table 9 shows the countries in each group. The variety of countries in each grouping reminds us that the technique that we use sorts countries into groups not based on directly observable characteristics, but based on the conditional distribution of the savings rates. In other words, the independent variables have similar effects on savings for each country in a specific group.

The estimation results appear in Table 10. Focusing first on the bottom rows of this table, we see that only banking center and capitalization are significant predictors of group membership. Being a banking center reduces the probability of being classified into Classes 2 or 3, and having higher stock market capitalization reduces the probability of being classified into Class 2, holding all else constant. As discussed above, these predictors are used in conjunction with the conditional distribution of savings rates to find the grouping that best fits the data.

The top rows of Table 10 provide the regression coefficients for each group and the last column presents the p-value for the Wald test that the coefficients are equal across groups. The low p-values indicate that none of the regression coefficients are equal across the four groups. Focusing first on the regression coefficients for the Class 1 group, we see that none of the coefficients on the banking variables are significant. Because Class 1 is the largest group of countries, this is consistent with previous findings that bank finance is not a significant determinant of savings. However, when we examine the results for the remaining three groups, we see that we need to temper that conclusion: Bank finance is not a significant determinant of savings in several countries, but it is correlated with aggregate savings rates in many others.

The regression coefficients for Class 2 highlight the importance of foreign influence. The marginal effect of the *FOREIGN-LOCAL* ratio on savings is positive. It is reduced somewhat by higher levels of total bank lending, but the effect remains positive for all countries in Class 2. Recall that the typical country in this group has a low level of stock market development and also the lowest level of

total bank lending/GDP. In these countries, the influence of foreign banks may be supplementing a lack of local financial development. Although the coefficient on the *DOMESTIC-CB* ratio is negative and significant, the interaction of this variable with total bank lending is positive and significant, reducing the marginal effect. These coefficients imply that for a country with a median level of total bank lending in Class 2, the marginal effect of this variable is close to zero.

In contrast, in Class 3, a higher share of domestic credit has a positive effect on savings. Although that impact is reduced somewhat as more total lending occurs within the country, it remains positive for the country with the median amount of bank lending. To the extent that presence of banks within the country lowers the cost of savings or increases the benefits, this result suggests that these effects are particularly important when total bank activity is low. It is also important to note that this is the only group of countries for which the total bank lending variable enters the regression positively and significantly. Finally, although the coefficient on *FOREIGN-LOCAL* lending is positive, its interaction with total bank lending is negative. Thus, for the typical country in Class 3 with the median amount of total bank lending, the net effect of a greater share of foreign lending in this group is negative and significantly more so at higher levels of total credit. Taken together, the results for Class 3 suggest that for this group of countries, more bank finance from domestic banks is associated with higher savings rates, especially if credit comes from a local bank. Interestingly, this is the class with the highest savings rates, but lowest levels of openness and foreign bank influence.

Class 4 is the class in which foreign bank influence has the largest positive effect. The negative coefficient on the *FOREIGN-LOCAL* ratio for Class 4 is more than offset by the positive interaction term of this variable and total bank lending. Similar to what we find in the growth regression results, for the country with the median amount of total bank lending in Class 4, higher involvement of foreign banks relative to local banks is associated with higher savings rates. In interpreting this result, it is important to realize that this is the class in which the typical country has higher values for total bank lending-GDP and has higher income, but the lowest saving rates. One possible explanation is that a sufficiently developed domestic financial system is necessary to facilitate and enable the flow of foreign credit into domestic

savings. Alternatively, financially more developed countries may be able to channel the competitive pressure resulting from foreign bank presence into new financial products that encourage savings. We also find that a higher share of domestic credit relative to cross-border credit increases the saving rate significantly, especially at lower levels of total credit.

6 Conclusion

We have shown in both growth and savings regressions that the influence of bank finance is not homogeneous across countries. Our empirical technique has allowed us to group countries based on the conditional distribution of growth or savings rates and additional predictor variables. A main contribution of our work is that our method lets the data tell us which variables are important for grouping, instead of imposing *a priori* restrictions. Furthermore, we provided a more careful examination of the impact of finance on growth and saving by differentiating credit by the nationality and type of lending.

Our most important finding is that heterogeneity is important: bank lending does not have the same effect on growth or savings in all countries. Country characteristics such as the extent of stock market development, the degree of rule of law, and even the development of the banking sector itself vary considerably across countries and affect the productivity of bank lending in encouraging growth and savings.[14] The impact of bank lending on growth also varies by the nationality and type of lending. In some countries, foreign banks may supplement a lack of domestic financial development. In other countries, our results are consistent with the idea that foreign bank influence may interfere with the learning-by-doing necessary to grow the domestic financial system.

Growth regressions show that the effect of bank finance on growth and the effect of foreign bank involvement depend on how well developed the banking sector is. The presence of domestic lenders is important but only once a threshold level of bank development is reached. Countries that can take advantage of the positive growth impact of domestic lending are more likely to have a stronger rule of law and a less capitalized stock market. In countries with underdeveloped banking sectors, the influence of

[14] Interestingly, our results do not support the theory that macroeconomic conditions such as inflation, government consumption or trade influence the effect of bank lending on growth or savings.

foreign lenders relative to local lenders can be detrimental to growth. Savings regressions show that the effect of lender nationality varies across countries. Significant foreign influence encourages savings in countries with low average savings rates. However, in the group of countries with the highest savings rates, foreign lending discourages savings.

An important conclusion for policy makers is that the relationship between financial development and economic development is complex: There are multiple dimensions of financial sector development that interact with each other and additional country characteristics to produce long-run growth.

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Table 1: Descriptive Statistics

	Cross Section		Panel			
Variable	Mean	SD	Mean	SD	Definition	Source
GROWTH	2.5	1.48	2.36	2.311	Average annual growth rate of real per capita GDP	World Bank Development Indicators
SAVINGS	19.54	9.29	20.88	9.92	Average domestic savings rate	World Bank Development Indicators
BANK	1.23	.966	1.56	1.16	Total Bank Lending/GDP	IMF and Bank For International Settlements
FOREIGN-LOCAL	.227	.396	.314	.347	(Cross Border + Affiliate Loans)/Local	IMF and Bank For International Settlements
DOMESTIC-CB	18.95	26.61	16.84	24.64	(Local +Affiliate Loans)/Cross Border	IMF and Bank For International Settlements
CAPITALIZATION	25.17	42.91	35.71	48.42	Stock market capitalization/GDP	World Bank Global Development Finance and Demirguc-Kunt and Levine (2001)
SCHOOL	76.40	21.33	80.47	25.30	Average secondary school enrollment rate	World Bank Development Indicators
GOVCON	15.47	4.89	16.08	5.67	Average government consumption/GDP	World Bank Development Indicators
INFLATION	10.82	19.83	21.62	44.25	Average CPI inflation rate	World Bank Development Indicators
$LN(Y_0)$	8.65	.906	8.98	1.03	LN(initial real GDP per capita)	World Bank Development Indicators
LAW	.005	.775	.238	.914	Rule of law Index	World Bank Governance Indicators
TRADE	84.38	38.11	76.65	43.07	Average (Exports + Imports)/GDP	World Bank Development Indicators

Table 2: Growth and Savings, 1995-2010

	(1)	(2)	(3)	(4)	(5)	(6)
	GROWTH	GROWTH	GROWTH	SAVINGS	SAVINGS	SAVINGS
BANK	-0.221	-0.061	-0.868***	-1.351	-1.257	-5.967**
	(0.137)	(0.193)	(0.285)	(1.820)	(1.293)	(2.256)
CAPITALIZATION	0.003	-0.005**	-0.005	0.019	0.029	0.048*
	(0.003)	(0.002)	(0.004)	(0.049)	(0.026)	(0.029)
SCHOOL	0.012	0.029**	0.036**	-0.086	-0.059	-0.107
	(0.016)	(0.013)	(0.017)	(0.085)	(0.078)	(0.092)
GOVCON	-0.075*	-0.061**	-0.080*	-0.655	-0.332	-0.623
	(0.039)	(0.028)	(0.043)	(0.404)	(0.280)	(0.387)
INFLATION	0.011	0.004	0.007	0.006	-0.038	-0.013
	(0.021)	(0.004)	(0.004)	(0.196)	(0.027)	(0.030)
$LN(Y_0)$	-1.145***	-1.177***	-1.203***	4.813	5.528**	7.020**
	(0.297)	(0.373)	(0.386)	(3.409)	(2.588)	(3.023)
LAW	1.022***	0.644**	0.951***	1.854	-0.262	0.519
	(0.329)	(0.274)	(0.346)	(2.222)	(1.957)	(2.282)
TRADE	-0.000	0.006**	0.001	0.028	0.019	0.001
	(0.003)	(0.002)	(0.005)	(0.043)	(0.021)	(0.027)
FOREIGN-LOCAL			-3.192***			-11.034
			(1.169)			(7.724)
DOMESTIC-CB			-0.036*			-0.236*
			(0.021)			(0.118)
FOREIGN-LOCAL*BANK			0.929***			3.924**
			(0.251)			(1.679)
DOMESTIC-CB*BANK			0.042			0.296*
			(0.030)			(0.169)
Constant	12.350***	11.039***	12.650***	-5.969	-18.211	-16.895
	(2.151)	(2.636)	(2.881)	(20.527)	(16.988)	(19.466)
Observations	41	81	58	43	87	64
R-squared	0.50	0.25	0.45	0.39	0.23	0.30

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3: Fit Statistics for Growth Mixture Models

	LL	BIC(LL)	Class.Err.	R^2
1-Class Regression	-642.347	1341.981	0	0.1181
2-Class Regression	**-582.23**	**1309.882**	**0.0161**	**0.4401**
3-Class Regression	-540.24	1314.036	0.0174	0.551
4-Class Regression	-508.849	1339.388	0.0121	0.6
5-Class Regression	-482.117	1374.058	0.0271	0.7497

Table 4: Class Profiles for Two-Class Growth Model, Median Values

	Class 1	Class 2
Class Size	.57	.43
GROWTH	1.91	2.01
LN(Y_0)	8.48	9.92
SCHOOL	67.06	97.79
BANK	.90	1.92
FOREIGN-LOCAL	.19	.22
DOMESTIC-CB	9.44	6.98
LAW	-.41	1.10
TRADE	59.49	67.44
CAPITALIZATION	15.31	27.19
GOVCON	12.07	18.94
INFLATION	10.30	4.43
BANKING CENTER (Mean Value)	.04	0

Table 5: County Classification for Two-Class Growth Model

class 1	**p(class1)**	**class 2**	**P(class2)**
Argentina	1	Austria	0.999
Bangladesh	1	Belgium	0.986
Bulgaria	0.998	Botswana	0.872
Bolivia	0.999	Canada	0.990
Brazil	0.999	Switzerland	0.884
Colombia	1	China	1
Ecuador	1	Cyprus	0.997
Fiji	0.999	Czech Republic	0.912
Ghana	1	Germany	0.997
Guatemala	1	Denmark	0.999
Hong Kong SAR, China	0.999	Spain	0.984
Honduras	1	Finland	0.999
Hungary	0.941	France	0.995
Indonesia	1	United Kingdom	0.881
India	1	Greece	0.942
Jamaica	1	Croatia	0.963
Jordan	1	Ireland	0.996
Japan	0.999	Iceland	0.999
Kenya	1	Israel	0.953
Morocco	1	Italy	0.842
Mexico	1	Korea, Rep.	0.999
Mongolia	1	Lithuania	0.998
Malaysia	0.999	Latvia	0.999
Nepal	1	Malta	0.999
Pakistan	1	Mauritius	0.999
Panama	0.999	Netherlands	0.995
Peru	1	Norway	0.999
Philippines	1	Poland	0.927
Paraguay	1	Portugal	0.999
Romania	0.999	Slovak Republic	0.991
Russian Federation	0.999	Slovenia	0.996
Saudi Arabia	0.851	Sweden	0.993
Swaziland	1	United States	0.934
Thailand	0.999		
Turkey	0.998		
Uruguay	0.980		
Venezuela, RB	1		
South Africa	1		

Table 6: Results for Growth Mixture Models

	Class 1	Class 2	Wald Test p-value
BANK	.221	-.341*	.13
	(0.327)	(0.198)	
FOREIGN-LOCAL	-1.418***	.337	.15
	(0.503)	(1.089)	
DOMESTIC-CB	-0.013*	-0.065**	
	(0.007)	(0.029)	
FOREIGN-LOCAL*BANK	.238*	-0.267	.14
	(0.123)	(0.316)	
DOMESTIC-CB*BANK	-.001	0.034***	.00
	(0.004)	(0.011)	
$LN(Y_0)$	-0.778***	-2.56***	.00
	(0.294)	(0.294)	
SCHOOL	.008	.003	.77
	(0.013)	(0.008)	
Error Variances	3.75***	1.84***	
	(0.479)	(0.314)	
R^2	.22	.69	
Predictor Variables			
BANKING CENTER		-2.4775	
		(2.353)	
LAW		4.07***	
		(1.165)	
CAPITALIZATION		-.046***	
		(0.017)	
TRADE		-.003	
		(0.017)	
GOVCON		.044	
		(0.074)	
INFLATION		-.033	
		(0.026)	

Robust standard errors are in parentheses. ***significant at 1%, **significant at 5%, *significant at 10%

Table 7: Fit Statistics for Savings Mixture Models

	LL	BIC(LL)	Npar	Class.Err.	R^2
1-Class Regression	-1064.4	2186.09	13	0	0.1498
2-Class Regression	-970.222	2085.866	33	0.0157	0.65
3-Class Regression	-904.569	2042.694	53	0.0219	0.7988
4-Class Regression	**-855.627**	**2032.945**	**73**	**0.0338**	**0.8465**
5-Class Regression	-811.765	2033.354	93	0.0163	0.8725

Table 8: Class Profiles for Four-Class Savings Model, Median Values

	Class 1	Class 2	Class 3	Class 4
Class Size	.48	.21	.18	.14
SAVINGS	21.6	15.3	33.3	12.7
$LN(Y_0)$	9.03	9.1	8.9	9.65
SCHOOL	85.0	84.7	69.6	89.8
BANK	1.13	1.12	1.27	1.77
FOREIGN-LOCAL	.21	.23	.14	.29
DOMESTIC-CB	7.51	6.75	12.37	9.46
LAW	.13	.10	.07	.77
TRADE	59.5	74.6	57.0	89.0
CAPITALIZATION	18.9	4.3	32.9	26.6
GOVCON	15.2	15.4	11.7	16.4
INFLATION	7.6	8.4	7.6	9.07
BANKING CENTER (Mean Value)	.04	0	0	.05

Table 9: Countries for Four Class Savings Mixture Model

Class 1	**P(1)**	**Class 2**	**P(2)**	**Class 3**	**P(3)**	**Class 4**	**P(4)**
Argentina	1.00	Bulgaria	1.00	China	1.00	Barbados	0.98
Australia	1.00	Cyprus	1.00	Indonesia	1.00	Botswana	0.96
Austria	1.00	France	0.61	India	1.00	United Kingdom	1.00
Belgium	1.00	Guatemala	1.00	Ireland	1.00	Ghana	1.00
Bangladesh	1.00	Croatia	0.97	Iran, Islamic Rep.	1.00	Greece	1.00
Bolivia	1.00	Iceland	1.00	Korea, Rep.	1.00	Hong Kong SAR, China	0.87
Brazil	0.71	Kenya	1.00	Kuwait	1.00	Honduras	1.00
Canada	1.00	Lithuania	1.00	Mongolia	1.00	Israel	1.00
Switzerland	1.00	Latvia	0.99	Malaysia	1.00	Jamaica	1.00
Colombia	1.00	Malta	1.00	Norway	1.00	Jordan	1.00
Czech Republic	0.93	Portugal	1.00	Russian Federation	1.00	United States	1.00
Germany	1.00	Paraguay	1.00	Saudi Arabia	1.00		
Denmark	1.00	Romania	1.00	Thailand	1.00		
Ecuador	1.00	Swaziland	1.00	Venezuela, RB	1.00		
Spain	1.00	Uruguay	0.58				
Finland	1.00						
Fiji	1.00						
Hungary	1.00						
Italy	0.91						
Japan	1.00						
Morocco	1.00						
Mexico	1.00						
Mauritius	1.00						
Netherlands	1.00						
Nepal	1.00						
New Zealand	1.00						
Pakistan	1.00						
Panama	1.00						
Peru	1.00						
Philippines	1.00						
Poland	0.50						
Slovak Republic	1.00						
Slovenia	1.00						
Sweden	1.00						
Turkey	1.00						
South Africa	1.00						

Table 10: Results for Savings Mixture Models

	Class 1	Class 2	Class 3	Class 4	Wald Test p-value
BANK	0.579	-0.275	5.92**	-2.77***	.00
	(0.511)	(0.452)	(2.717)	(0.823)	
FOREIGN-LOCAL	.730	8.05***	7.42	-2.21	.00
	(1.180)	(1.784)	(6.005)	(2.614)	
DOMESTIC-CB	-0.024	-0.145***	0.181	0.376***	.00
	(0.029)	(0.029)	(0.110)	(0.034)	
FOREIGN-LOCAL*BANK	.004	-1.05**	-8.10**	7.84***	.00
	(0.274)	(0.522)	(3.528)	(1.215)	
DOMESTIC-CB*BANK	-.006	0.147***	-0.055*	-0.142***	.00
	(0.007)	(0.028)	(0.029)	(0.032)	
$LN(Y_0)$	3.72***	0.888	0.693	8.46***	.00
	(0.726)	(0.780)	(2.333)	(0.781)	
SCHOOL	-.052***	0.095***	.074	-0.334***	.00
	(0.018)	(0.026)	(0.106)	(0.032)	
Error Variances	10.17***	5.52***	37.08***	6.48***	
	(1.518)	(0.605)	(9.026)	(1.041)	
R^2	.60	.79	.42	.92	
Predictor Variables					
BANKING CENTER		-6.69**	-6.66**	-1.28	
		(2.919)	(2.706)	(2.139)	
LAW		0.150	-0.367	-0.127	
		(0.685)	(0.537)	(0.405)	
CAPITALIZATION		-.082**	.010	0.008	
		(0.039)	(0.009)	(0.009)	
TRADE		0.018	0.012	0.012	
		(0.018)	(0.010)	(0.012)	
GOVCON		.008	-0.015	.057	
		(0.114)	(0.095)	(0.072)	
INFLATION		.005	.020	.015	
		(0.018)	(0.016)	(0.016)	

Robust standard errors are in parentheses. ***significant at 1%, **significant at 5%, *significant at 10%