Dynamic spatial competition models offer a method for understanding geographic patterns of financial service provision over time. By comparing simulations to actual data for spatially distinct markets, we are able to identify how financial service providers make bank location and expansion decisions. The motivating factor behind location decisions can be profit maximization (as might be anticipated for commercial banks) or overall levels of financial access (as might be anticipated for government development banks).

This CFSP Concept Note provides an introduction to the use of dynamic spatial competition models in simulating expansion decisions by two financial service providers. Using these techniques for analysis allows for the examination of location decisions of a government development bank and a commercial bank. Outcomes from various scenarios can then be utilized to determine the implications of location decisions for overall welfare and total financial access.

WHY ARE SPATIAL MODELS IMPORTANT FOR POLICY?
The location decisions made by government and commercial banks are critical to conversations related to financial access, particularly in developing countries. Does bank ownership affect the expansion of the financial system? Are government banks crowding out the presence of private banks or are they improving access in poor and isolated areas? How do private banks change the behavior of government development banks?

Government ownership of banks is common around the world. On average, 42 percent of the equity of the 10 largest banks in 92 countries was owned by the government in 1995 (La Porta, Lopez-de-Silanes and Shleifer, 2002). While existing literature focuses on the influence of political objectives in the determination of lending policies of government banks (Sapienza 2004; Khwaja and Mian 2005; Din 2005; Micco, Panizza and Yanes 2007), the consideration of geographic location is also quite important in understanding the consequences of government ownership. In some cases, well-intended decisions regarding branch location by government banks may actually lead to reductions in welfare, as measured by total financial access. Government and commercial bank behavior is not only determined by the socio-economic characteristics of each location but also by the strategic interaction in the markets. If the banks have different objective functions, it will change not only profile of their target locations but also how they react to each other in spatially located markets.

CONSIDERING FINANCIAL SERVICES THROUGH THE LENS OF NETWORKS
The way that financial services are distributed to certain markets can be thought of through the lens of networks. A given market may be central in the sense of having a good road structure linking it to several other markets. Alternatively, a given market may be isolated and lack physical infrastructure connecting it
to other markets. A spectrum exists, where a market may be connected directly or indirectly (via second, third, or higher infrastructure links) to various other markets. Each market is distinguished by its interconnection with other markets.

These inputs are important for the model which follows. The model works within a matrix of the existing road network and the service scope of the financial service provider. It is assumed that people in a given location will travel to the closest location with a financial provider. However, the probability of actually receiving credit from a financial service provider may vary with distance. For example, a commercial bank may be less willing to extend credit to people from more distant locations. This fact can be incorporated into the model.

The use of a dynamic spatial model is particularly beneficial because it can account for interconnection among markets. Much of the existing literature treats markets as exogenous; markets are nodes connected by edges that form some derived network structure (Holmes, 2011; Ishii, 2005; Keniston et. al, 2012; Schmidt-Dengler, 2006). Alternatively, a dynamic spatial model explicitly captures both the actual characteristics of each market – such as wealth and population – and its location within the network of all markets, as measured by road networks. Each market, a point in space, is meaningful, as are the connections and the edge of the network.

The structure of the network plays a key role in the evolution of the overall market structure, as well as financial access outcomes. Financial service providers take into account the populations they serve, including those accessible by both direct and indirect links to specific markets. With the increasing availability of geo-coded information and transport networks, we can now explicitly incorporate networks into economic modeling more broadly.

A DYNAMIC SPATIAL COMPETITION MODEL
The model takes into account key features of the economy for a given country and is used to track a dynamic economic transition in which two financial service providers enter markets sequentially, with the sequence of moves calibrated to the ones observed in the data.

Financial service providers can open branches across a menu of possible locations. The two providers are allowed to enter the same location, competing for people demanding financial services. Several factors are at play here. The fraction of the population serviced in a given location is taken as endogenous, whereas the potential profit per person are exogenously given. Travel time affects the cost of transactions between the population and branches, reflecting both the cost incurred by people traveling to the branch and the cost of assigning loan officers to more remote locations without branches.

In making location decisions, financial service providers discount the future; they are forward-looking in taking into account the behavior of the other player. The two providers in the model are distinguished by their preferences, namely, we consider commercial banks whose main objective is profit maximization versus more altruistic government development banks, which take into account overall financial access. The dynamic game ends when all markets are occupied.

Using data to choose parameters
An important component of the model put forth here are the preferences – and the weight for each of those preferences – that financial service providers have. Other parameters refer to the outreach of each bank in a given location. Given the branch locations, government and private banks may have different policies of assigning loan officers to serve villages. Using data, we can select the best fit among different alternatives, including benchmarks.

The challenge here is the computational burden. To ease the computation, a grid search can be used to estimate two parameters: the weight put by the government development bank on commercial bank revenues and the scope of financial access reflected in reduction of financial services due to distance. For each combination of parameters, the game is solved for a set of locations (provinces), and the solution predicts the location of branches and credit access at the market (village) level. Mean squared errors are then computed between the predicted financial access or branch location and what is observed in the data. The parameter combination that minimizes the mean squared errors criterion is chosen as an estimate.
Using data for Thailand, Assunção, Mityakov, and Townsend assess whether the government’s Bank for Agriculture and Agricultural Cooperative (BAAC) and commercial banks have different objective functions, considering a range of possibilities from pure profit maximization to maximizing the total financial access.

**Features of the Thai example**

Background analysis of Thailand’s economy over the period of study provides information which can be incorporated into the model used by Assunção, Mityakov, and Townsend.

- This model considers only entry decisions and does not account for exit, as Thailand had a clear expansion of the financial system from 1986 – 1996, the period of study.

- BAAC and commercial banks compete in similar markets, although BAAC may have a different objective. The model assumes that the two sell homogenous services.

- Financial services are provided through a spatial network, and branches are opened in key locations. Given the bank network, village residents either travel to the branches via road networks, or are attended by loan officers.

- Striking differences are seen in the expansion of BAAC and commercial banks, suggesting that they seem to pursue different objectives. The model allows BAAC to have a different objective from the profit-maximizing behavior of commercial banks.

- There is evidence that the outreach of BAAC branches is higher than that of commercial bank branches. Thus, the model allows for heterogeneity in the outreach.

- The profile of villages with access to BAAC varies according to the presence of commercial banks at the provincial level.

**WHAT THE MODEL CAN TELL US ABOUT BANK BEHAVIOR & TOTAL FINANCIAL ACCESS**

Solving the model for a number of examples can shed light on the differences in behavior between the two financial service providers. Outcomes for Thailand using data on BAAC and commercial banks are provided to illustrate the dynamics of the model and the role of the main parameters. (Note: in order to simplify analysis, these examples allow at most one branch per location and assume that entry locations and villages coincide.)

**Bank behavior in the presence of other banks**

The model sheds light on how the behavior of government development banks changes when they face commercial banks, as compared to an economy without commercial banks.

In Thailand, the model suggests that the behavior of BAAC changes substantially when commercial banks are present. BAAC’s goal is to maximize total financial access. In the absence of commercial banks, BAAC expands first into more populated areas. In the presence of commercial banks, BAAC has an incentive not to serve the best markets first, since it anticipates that commercial banks will expand to these areas soon. Thus, the model shows BAAC moving into less populous and more distant areas. With or without BAAC, commercial banks serve the best locations first.

The first best equilibrium in this scenario is that BAAC occupies the most profitable locations conditionally on the fact that people can travel from adjacent locations to get financial services. So, it tries to spread its access widely to all connect components of a network first and then fills the less profitable locations later.

These model simulations match what is observed in the data: BAAC serving less profitable and more distant locations first. This means that the most profitable locations are underserved by BAAC in the hope that they will be served in the future by the commercial banks. The lack of competition from BAAC results in the commercial bank behaving less competitively and underserving some locations.

**Welfare implications**

The behavior of commercial and government development banks has implications for efficiency
and overall welfare. The model can be used to run simulations to identify the parameter values which would maximize total financial access, given each financial institution’s preference for profits and financial access.

REFERENCES

Main Study

Other Studies Mentioned in the Text


