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A Model of Macroprudential Frictions for Indirect Monetary Policy in The Bahamas

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Abstract

The paper proposes a dynamic stochastic general equilibrium (DSGE) model of indirect monetary policy for The Bahamas. The model consists of 'macroprudential frictions' including a financial accelerator mechanism for the contract between entrepreneurs and financial intermediaries; a borrowing constraint for the contract between credit-constrained households and financial intermediaries; and 'distance-to-default' as a proxy for financial intermediaries' balance sheet strength. The data used to estimate the model are a mix of U.S. data—a proxy for financial-sector shocks—and Bahamian macro aggregates. The results show that macroprudential shocks are substantial drivers of welfare during recessions, while standard productivity, monetary policy, and investment-specific shocks drive welfare outside of recessions. Housing price dynamics, banking sector risk premiums, and discount factor shocks account for most of the variance in the output and consumption decompositions. Comparing the model to one without macroprudential frictions reveals that ignoring relevant policy specifications leads to significant 'policy mistakes.

Keywords: Macroprudential Frictions, Monetary Policy, Financial Stability.

Introduction

The Bahamas' profile as a small, open, dependent economy with a fixed exchange rate regime has inherently shaped the nature of monetary policy in the country and, consequently, the use of direct instruments. Therefore, this is a key contrast between the Bahamian economy and other small-open dependent economies and larger economies, which have a different economic profile. Generally, central banks in larger economies, especially advanced economies, utilise and manipulate traditional monetary policy instruments (whether individually or in combination) for control of the money supply and/or the cost of funds to achieve intended economic outcomes. The standard direct monetary policy tools include those that operate by setting or limiting prices (interest rates) and quantities (money supply); such as the discount rate (i.e. interest rate controls), credit controls/ceilings, and directed lending. In contrast, key indirect monetary policy tools include those that act through market forces, such as the reserve requirement ratio, open market operations and central bank lending facilities [1].

A key institutional constraint is the classic monetary policy trilemma. With a fixed exchange rate vis-à-vis the U.S. dollar and relatively open capital flows, The Bahamas cannot simultaneously maintain full monetary autonomy. In practice, this means the standard short- term interest rate policy has limited room to persistently deviate from U.S. conditions without jeopardising the peg. In this context, we use the term indirect monetary policy to describe instruments that operate primarily through domestic balance sheets, risk spreads and regulatory constraints, rather than through an independently set policy rate. Examples include reserve requirements, loan-to-value limits, and other measures that affect credit conditions even when the nominal policy rate is primarily tied to external benchmarks.

The standard monetary policy approaches of central banks in larger and advanced economies, however, have limited effectiveness for small, open economies, such as The Bahamas (Francis, 1986). The presence of a fixed exchange rate regime, which limits monetary policy independence, also shapes the conduct of monetary policy and the effectiveness of standard instruments. The Central Bank of The Bahamas—mandated since 1974 to carry out independent monetary policy in The Bahamas—has operated with the objectives of fostering monetary and financial sector stability, economic growth and development, and protecting the fixed exchange rate regime. Concerning the latter, support of the 1:1 parity between the Bahamian dollar and the U.S. dollar—which has existed since 1966—has also played an integral role in the Bank's monetary policy approach. The Central Bank of The Bahamas has statutory powers to implement standard monetary policy instruments, which it does using tools commonly used by central banks globally. These include the discount (bank) rate, the reserve requirement ratio, open market operations, and credit controls. The use of "moral suasion", identified by the Bank as an informal tool, supplements the formal ones [2].

The realities of the country's economic profile and its fixed exchange rate regime result in limited pass-through effects from the use of direct monetary policy instruments. In this context, this paper introduces a dynamic stochastic general equilibrium (DSGE) model in order to measure the impact of alternative policy specifications. The study examines whether replacing or supplementing monetary policy mechanisms with these tools will augment the effectiveness of monetary policy in The Bahamas. The model is a modification of the model introduced by Smets and Wouters (2003). Included are macroprudential frictions such as a financial accelerator mechanism (Bernanke, 1999) for the contract between entrepreneurs and financial intermediaries, allowing for borrower leverage and an external finance premium. The second is a borrowing constraint, similar to that of Kiyotaki and Moore (1997) for the contract between credit-constrained households and financial intermediaries, imposed because of moral hazard problems that prevent borrowers from financing beyond the liquidation value of collateral. Moreover, the "distance-to-default" measure (Merton, 1974) is applied to the financial sector as a proxy for balance sheet strength. For a pre-crisis to post-crisis comparison, the model was evaluated over the 2007-2009 period to demonstrate the maximum impact of effective macroprudential policy. Specifically, this period began with the culmination of robust economic performance, followed by the housing- and financial-market-induced Global Financial Crisis (GFC) and the ensuing "Great Recession".

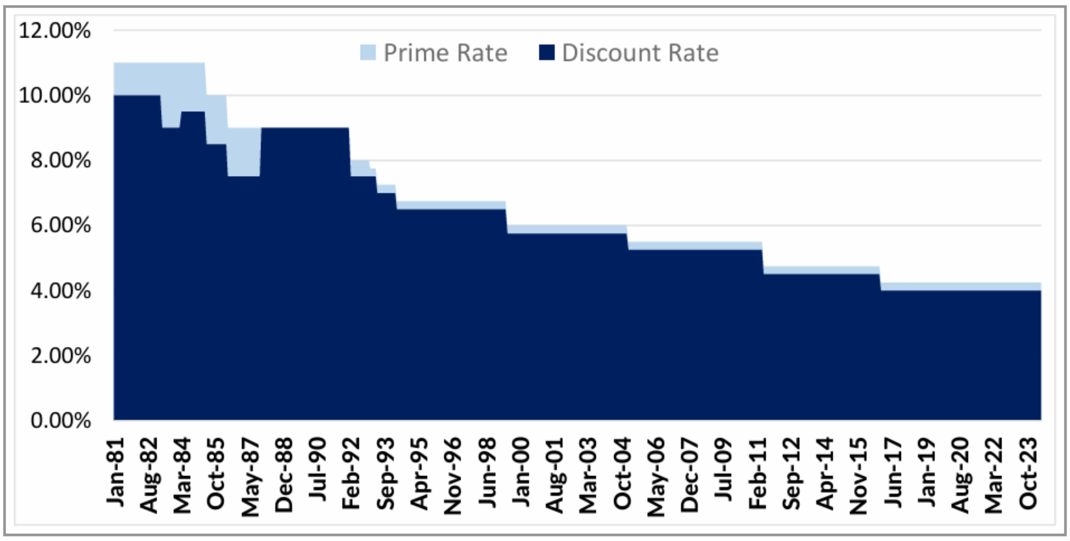
The remaining sections of this paper include a literature review of the empirical body of research, with particular focus on the models introduced by Smets & Wouters (2003), Bernanke, Gertler and Gilchrist (1999), Kiyotaki and Moore (1997), and Merton (1974). Further, Section 3 provides context on the limited pass-through of interest rates in The Bahamas, with several time-series comparisons of various interest rate indicators, a regression of the discount rate, and a breakdown of commercial banks' lending rates by main categories. In Section 4, the financial friction model is outlined, and in Section 5, the model and estimation results are described. Section 6 discusses the findings, their implications for policy, and concludes with areas for further research [3].

Instruments of Monetary Policy in The Bahamas

The more commonly employed instruments of monetary policy in The Bahamas are changes in the discount rate, selective credit controls and reserve requirements. These are supplemented by the informal moral suasion tool. The Central Bank of The Bahamas' stated objectives of its monetary stance are to maintain stable credit conditions, support the exchange rate, and promote economic developments.

Discount Rate

The discount rate (Bank rate) is one of the direct monetary policy instruments used in The Bahamas. When the central bank adjusts the discount rate, clearing banks in practice follow suit with a corresponding adjustment in the prime lending rate, which is the underlying benchmark loan rate for credit facilities from commercial banks. Changes in the discount rate have followed a downward trend, usually aimed at stimulating credit growth to support economic growth. There have been no upward adjustments to the Bank rate since December 1987, when the rate was raised to 9.00% from 7.50% discourage commercial banks' use of central bank reserves. Other reasons for relatively rare increases in the benchmark rate include differentials between domestic and international interest rates and heightened demand for credit [4]



Source: Central Bank of The Bahamas

Credit Controls

Credit controls, along with changes in the discount rate, are the more commonly employed monetary tools in The Bahamas. Credit controls have been employed in a contractionary manner during periods of unsustainable private-sector demand and in an expansionary manner following shocks, and to provide forbearance to borrowers. Tightening controls have included imposing equity requirements (i.e., down payments), which were typically relaxed when credit conditions returned to sustainable levels. More recently, credit controls were implemented in the aftermath of shocks to the economy, such as major hurricanes and, most recently, the COVID-19 pandemic. Relaxed credit controls included increases in borrowers' debt service ratios, waivers of equity contributions, and loan payment deferrals [5].

Reserve Requirement

The Reserve Requirement Ratio (RRR), although an existing instrument, has never been utilised. The Ratio has been unchanged at 5.0% since 1974. In May 1981, the secondary reserve ratio (liquid asset ratio) was established, specifying how the LAR was to be calculated. The ratio was set at 20% against demand deposits, 15% against time and savings deposits and 15% against fixed deposits and borrowing from commercial banks and Other Local Financial institutions.

Model Design

In terms of model design, our analysis adapts the framework of Suh and Walker (2016), who combine the Smets and Wouters (2003) medium-scale New Keynesian model with a comprehensive set of financial frictions, including a Bernanke et al. (1999) financial accelerator, Kiyotaki–Moore (1997) collateral constraints, and a Merton (1974) distance-to- default measure for banks. Our contribution is threefold. First, we customise their model to fit the institutional and macro-financial features of The Bahamas, a small open economy with a hard peg to the U.S. dollar and limited conventional monetary tools. Second, we estimate the model using a mix of U.S. financial data and Bahamian macroeconomic aggregates, thereby measuring how external financial shocks spread into Bahamian consumption, investment, and output. Third, we compare versions of the model with and without financial frictions to evaluate how neglecting macroprudential channels can distort the understanding of shocks and result in potentially misguided policy advice.

Review of Literature

Varied models have been developed that estimate the sources of business cycle movements and analyse the impacts of shocks on output. The one proposed in this paper is a modification of that introduced by Smets and Wouters (2003). The Smets-Wouters (SW) model shares key features with DSGE models and traditional Keynesian models. Additional frictions, as well as structural shocks, were introduced to the model. These enabled parameter estimation via Bayesian techniques and analysis of the sources of movements in the business cycle. Empirical estimates revealed a considerable degree of price and age stickiness in the euro area, which was also useful for analysing monetary policy. The effects of two types of monetary shocks: temporary and persistent, were also measured, as were a number of non- monetary shocks [6].

Another frequently included element in these DSGE models is the presence of contracts between economic agents (particularly consumers and firms) and financial intermediaries. Building on developments in the economics of imperfect information from the 1970s, Bernanke, Gertler, and Gilchrist (1996) examine the financial accelerator—the concept that changes in credit market conditions amplify and propagate macroeconomic shocks. The proposed model includes a partial equilibrium for the lender (principal)/borrower (agent) relationship and a general equilibrium for macroeconomic dynamics that incorporates the financial accelerator mechanism into a business-cycle model. Empirical findings, which were drawn from a panel of manufacturing firms, revealed that smaller firms showed more procyclical variation in inventories and short-term debt than do larger firms, consistent with the hypothesis that consumers, small firms and firms with weak balance sheets are more severely impacted by economic downturns, and therefore should receive reduced access to credit, relative to other types of borrowers, following economic shocks.

In a subsequent study, Bernanke et al. (1999) also developed a DSGE model to examine the role of credit-market frictions in business-cycle fluctuations. Similar to the 1996 study, a financial accelerator is included. However, for the 1999 study, features were added to the financial accelerator to augment its empirical relevance. These included money and price stickiness to measure the impact of credit market frictions on monetary policy transition, and a decision lag for investment to allow for a lead-lag relationship between asset prices and investment and to generate hump-shaped output dynamics. Similar to the model in the 1996 study, a partial equilibrium component was embedded in the generalised model (in the 1999 study, the lender-entrepreneur relationship) to allow for endogeneity of the safe interest rate, capital return, and the relative price of capital [7].

Kiyotaki and Moore (1997) more closely examine the enforceability of debt contracts vis-à-vis Bernanke et al (1996). The latter study affirmed that consumers and small firms, which are highly susceptible to macroeconomic shocks, should have a lower share of credit extended to them at the onset of recessions, as borrowers with higher agency costs should receive a lower share of credit. By comparison, Kiyotaki and Moore (1997) incorporate financial frictions via the limited enforceability approach, which assumes the lack of perfect enforceability of debt contracts, limited recovery for the lender in the case of default, and the imposition of credit restrictions in response. Therefore, for this model, durable/collateralizable assets play a dual role as factors of production and collateral on loans.

The work closest to our modelling framework is that of Suh and Walker (2016). They augment the Smets–Wouters (2007) U.S. model with a financial accelerator, collateral constraints for borrowing households, and a banking sector whose balance sheet strength is summarised by a distance-to-default (DTD) measure derived from Merton (1974). Their main objective is to "take financial frictions to the data" in a closed-economy setting and to quantify how different financial shocks contribute to business cycle dynamics. Our model follows their structure closely, including the specification of the financial accelerator and the DTD-based banking block, but applies it to a small open, pegged economy and extends the empirical analysis to combine U.S. financial variables with Bahamian macro data. We are therefore explicit in treating Suh and Walker (2016) as the baseline model on which we build [8].

To quantify the balance sheet strength of firms, the model proposed in this paper employs the distance-to-default as a proxy measure, which allows for an assessment of the firm's credit risk; a measure based on the structural default model of Merton (1974), in which equity is treated as a European call option (Merton Model). By back-solving the Black-Scholes Options pricing formula, the Merton Model derives the firm's implied market value and volatility (Shah, Singh and Aggarwal, 2023). Meanwhile, Vasicek (1984) extended the Merton Model, with the proposed model diverging from earlier methods of credit analysis, with a particular focus given to market (information) efficiency. Nevertheless, like Merton, Vasicek (1984) assume the firm's equity to be an option, with a key extension being cash payouts, including dividends made in the event of default. Crosbie and Bohn (2003) also proposed a model for default risk by the Moody's KMV Company ("MKMV Model"). The model provides a measure of "Expected Default Frequency (EDF)", the probability of default for a publicly traded company during the forthcoming year. Distance-to-default is one component of the model, along with estimated asset value and volatility, and default probability [9].

A number of further studies have involved extensions of the model proposed by Bernanke et al (1999) to explain the role of the financial conditions in the business cycle. Gertler, Gilchrist and Natalucci (2005) developed a model of a small open economy that examined the linkage between exchange rate regime and financial distress. The model was calibrated to reflect the behaviour of the Korean economy during the 1997-1998 financial crisis period in the country. In addition to extensions from the Bernanke et al (1999), the model was modified to include a measure for changes in productivity and to link borrower balance sheets to demand for capital. Shocks were applied to illustrate how the exchange rate regime (flexible, fixed or hybrid) might exacerbate welfare losses. Similar to Gertler et al (2005), Lee and Rhee (2013) developed a model that included an extension of the model of Bernanke et al (1999), which included financial factors. The main modification to Bernanke et al was the proposal of a two- country economy, one being the small open economy. Also similar to Gertler et al (2005) was the study's use of the Korean economy to estimate the DSGE model. However, the model used by Lee and Rhee (2013) was estimated using Bayesian methods, as was done in a later study by Smets and Wouters (2007) and Adolfson, Laséen, Lindé and Villani (2007). Kitano and Takaku (2018) incorporated the financial accelerator mechanism of Bernanke et al (1999) in their model of a small open economy, the structure of which is consistent with the one developed in studies by Galí and Monacelli (2005) and Faia and Monacelli (2008). Similar to Gertler et al (2005), Kitano and Takaku (2018) analysed the welfare impacts of monetary policy with respect to the exchange rate regime. The findings indicate superiority of the flexible exchange rate for the economy without the financial accelerator and superiority of the fixed exchange rate for the economy with the financial accelerator [10].

The Pass-Through Effects of Interest Rates: The Case of The Bahamas

The discount (bank) rate is the key monetary policy rate for The Bahamas and is linked to the commercial banks' prime lending rate. Central bank adjustments to the discount rate are followed by corresponding changes in the prime rate. Within the last twenty years, there have been three downward adjustments to the discount rate (February 2005, June 2011 and December 2016). The 2005 adjustment was prompted by persistent levels of excess liquidity, while the 2011 and 2016 lowering of the rate was attributed to providing support for a positive growth outlook. An analysis of trends in interest rates in The Bahamas over the past twenty years showed low pass-through effects when examining movements in the discount rate and other rates [11].

Table 1 shows regression results for the discount rate (independent variable) and the weighted average lending rate (dependent variable). Based on the results, the higher the adjusted R-squared statistic, the stronger the pass-through effect from the policy rate to the lending rate. According to the results for the weighted average lending rate (differenced) on the discount rate, an adjusted R-squared of 0.172 indicated the weak pass-through effect of a change in the policy rate. Hence, this indicates that the standard monetary policy for The Bahamas has little to no effect. Therefore, signalling that macroprudential policies need to complement the standard monetary policy to be effective in the market.

Table 1: Regression Output (Differenced Weighted Average Lending Rate on Discount Rate)

Dep. Variable:	Weighted average lending rate	**R-squared:**	0.180
Model:	OLS	**Adj. R-squared:**	0.172
Method:	Least Squares	**F-statistic:**	22.39
Date:	Fri, 25 Mar 2022	**Prob (F-statistic):**	7.17e-06
Time:	10:28:16	**Log-Likelihood:**	-119.92
No. Observations:	104	**AIC:**	243.8
Df Residuals:	102	**BIC:**	249.1
Df Model:	1		

	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
const	9.0577	0.484	18.717	0.000	8.098	10.018
Discount Rate	0.4427	0.094	4.732	0.000	0.257	0.628

Omnibus:	1.388	**Durbin-Watson:**	0.354
Prob(Omnibus):	0.499	**Jarque-Bera (JB):**	1.273
Skew:	0.128	**Prob(JB):**	0.529
Kurtosis:	2.522	**Cond. No.**	34.2

Notes:
[1] First Difference of Weighted average lending rate and Discount Rate are Cointegrated at a level of 1% significance, p-value: 0.4765.

The regression in Table 1 should be interpreted with caution. Over the sample period, there are only three discrete changes in the discount rate, which severely limit the statistical power of any pass-through regression and make the estimated coefficient and adjusted R^2 highly sensitive to specification choices. We therefore view this exercise as a descriptive complement to the DSGE analysis that follows, rather than as a stand-alone identification strategy. Our main conclusions about the limited pass-through of policy rate changes rely on the model-based impulse responses and the estimated importance of financial shocks, not on this reduced-form regression alone [12].

The Financial Friction Model

A financial friction in the business sector via the accelerator mechanism is introduced in the model. More specifically, there are two additional economic agents involved in the capital investment process, entrepreneurs and capital-goods producers. Entrepreneurs effectively choose the capital stock each period. Capital investment is financed by external borrowing and net worth. The net worth of the entrepreneurs is defined as the retained earnings from the previous period.

The key equation that characterises the financial accelerator mechanism is given as:

where K_t^p is the physical capital stock, Q_t is the price of capital, NW_t is the net worth of the entrepreneur, ε_t^{rp} is a shock to the risk premium and f is assumed to be an increasing function.

The equation shows that the external finance premium, defined by the ratio of expected return on capital to the intermediary's funding rate ($E_t R_{t+1}^K / R_t^f$), will be an increasing function of the ratio of total assets over net worth ($Q_t K_t^p / NW_t$).

The return on capital is determined by the marginal productivity of capital and the price change of capital:

The entrepreneurs' net worth is defined by net returns after repaying the debt obligation. The law of motion for the net worth is thus given by:

where ϑ is the survival rate of the entrepreneurs for each period. Equation (3) shows that the net worth of the surviving entrepreneurs is the retained earnings from the investment after subtracting the portion claimed by the intermediary. ε_t^{nw} is a shock to the entrepreneurs' net worth, which represents the unexpected gain or loss that affects the entrepreneur's balance sheet.

Given the size of the physical capital stock, entrepreneurs also determine the utilisation rate. It is assumed that capital utilisation is costly, with costs determined by $a(u_t)$, and the entrepreneurs' decision regarding capital utilisation is made by solving the following optimisation problem 1 :

Capital goods producers purchase I_t amounts of consumption goods at a price of one, and turn them into the same amount of new capital. Transformation costs, $s(\cdot)$, arise during the process, and the capital is resold to entrepreneurs at price Q_t. Capital goods producers maximise future discounted expected return, given by the following optimisation problem:

where ε_t^i is the investment-specific shock that affects the efficiency of the capital accumulation process.

1 The first-order condition is given by $MP_k = a'(u_t)$, which equates marginal benefit and marginal cost.

In terms of credit constrained borrowing households, they are distinguished by patient and impatient households. Impatient households have lower future discount parameters than patient households ($\beta' < \beta$). There is a continuum of agents in each household group. The economic size of each group is determined by its share of wage income, which is characterised by the parameter μ. Impatient households are borrowers in the steady state and around its neighbourhood. Households have preferences over not only consumption goods, but also housing goods [13].

Patient households maximise

where J is a composite of consumption and housing goods:

subject to the budget constraint:

In the utility function, C is consumption, H is housing goods and L is the labour supply. In the budget constraint, B is the nominal deposit, R_t is the nominal gross saving interest rate, P is the price of consumption goods, T is the lump-sum tax, Q^h is the nominal housing price and δ_h is the depreciation rate of housing goods. W_h is the wage received, and Div is the dividend income from firms. ε_t^{ψ} is a preference shock for the housing goods that affects housing demand. ε_t^{β} is a shock affecting the discount factor, which is different from the financial friction shock in the standard SW model. This is because the discount factor shock only affects the intertemporal consumption decision, while the financial friction shock in the SW model affects both the intertemporal consumption and investment decision, as it introduces a wedge between the rate at which households save and borrow [14].

Impatient households maximise:

Where

subject to the budget constraint:

and the collateral (loan-to-value) constraint:

The parameter m determines the steady state loan-to-value (LTV) ratio, which is the ratio of debt to collateral value. Noteworthy is that, the impatient households' ability to borrow is limited by the value of collateral assets that can be liquidated. Housing goods are used as collateral assets, and the constraint binds around the steady-state and its neighbourhood. The LTV ratio is assumed to vary over time, as ε_t^{dbt} denotes an external disturbance to lending standards.

The financial sector was modelled by focusing on the relationship between intermediaries' balance sheet and their ability to intermediate credit. This type of friction is believed to be a key factor during the 2007-2009 financial crisis.

Following Suh and Walker (2016), we use the distance-to-default as an observable variable to capture the riskiness of the financial sector. The DTD measure is constructed from a structural default model à la Merton (1974), in which equity is treated as a call option on the firm's assets and the implied asset value and volatility are recovered from market data. In our context, DTD serves as a summary statistic for bank balance sheet strength and directly enters the determination of interbank spreads [15].

Specifically, assume the firm's assets are financed by equity issued at time t denoted bySt , and zero-coupon debt issued at $t(Dt\ )$ with a face value of F and maturity date M. The market value of the firm at any date t is given by the sum of the market value of debt and equity. Therefore, the accounting identity $Vt = St + Dt$, where Vt denotes firm value, holds for each period. Under these assumptions, the bondholders are entitled to a time-M cash flow of $\min[VM,\ F]$ and since equity holders are the residual claimants, the value of equity at time M is given by $\max[VM - F, 0]$. At any time $t < M$, the value of these derivative securities is:

where the expectation is taken with respect to the risk-neutral probability measure and the risk-free rate r is assumed to be constant over time [16].

Assuming a geometric Brownian motion for firm value, Merton (1974) showed the probability of default for the firm can be backed out of equations (16) and (17), and is given by:

where $\varepsilon t{+}M$ is white noise.
The distance to default can then be defined as:
Default occurs when the ratio of firm value to debt (Vt/F) drops below unity or the log of the ratio is negative. The distance to default DDt can be interpreted as a z-score, which gives the number of standard deviations that the log of this ratio needs to deviate from its mean in order for default to occur. In other words, the probability of bankruptcy depends upon the distance between the current value of the firm's assets and the face value of its liabilities, adjusted for the expected growth in asset value relative to asset volatility. We stress that the modelling of bank risk via DTD is not novel to this paper; it is inherited from Suh and Walker (2016). Our contribution is to estimate and interpret this block in the context of the Bahamian financial system [17].

Model Specification and Results

Model Description and Estimation

In this study, a dynamic stochastic general equilibrium (DSGE) model of indirect monetary policy for The Bahamas was developed, with substantial "macroprudential frictions", which measure the impact of alternative policy specifications, such as changes to leverage ratios. The rationale for the model is that traditional monetary policy approaches, such as changes in the interest rate, have weak pass-through effects on the economy in The Bahamas due to the fact that it is a fixed exchange rate economy, pegged to the United States dollar, and has limited monetary policy tools.

Ideally, we would estimate the full model using financial and macroeconomic series for The Bahamas alone. In practice, however, high-frequency and long-span data on key financial quantities, such as market-based interest rate spreads, bank leverage, and housing prices, are either unavailable or too short and noisy for reliable estimation of the financial block. We therefore follow a two-pronged approach. First, we use U.S. financial series (interest rate spreads, housing prices, bank leverage) to discipline the dynamics of the financial accelerator and banking sector in a setting where these variables are well measured. Second, we combine these with Bahamian macro aggregates (consumption, investment, GDP deflator, long-term interest rates) to quantify how these estimated financial shocks transmit into the Bahamian economy. This strategy is motivated by evidence that U.S.-generated shocks have important spill overs to small open economies such as The Bahamas (e.g. Cormun and De Leo, 2020). However, we emphasise that it is an approximation. Our results should be interpreted as capturing the implications of a Suh–Walker style financial block embedded in Bahamian macro data, rather than as a literal statement about one-for-one co-movement of Bahamian and U.S. financial series.

The model is a modification of the standard Smets-Wouters (2003) set, which includes macroprudential frictions such as a financial accelerator mechanism of Bernanke (1999) that applies to the contract between entrepreneurs and the financial intermediaries, allowing for borrower leverage and an external finance premium. In addition, the model comprised a borrowing constraint, similar to Kiyotaki (1997), which applies to the contract between creditconstrained households and the financial intermediaries. The constraint is imposed because of moral hazard problems that prevent borrowers from financing beyond the liquidation value of the collateral. Further, the model introduces households that are credit-constrained because they are impatient, to use their housing goods as collateral, allowing housing market conditions to impact the business cycle. Finally, balance sheets of financial intermediaries are allowed to affect their ability to draw loanable funds and therefore to intermediate credit. Specifically, the 'distance-to-default' measure of Merton (1974), applied to the financial sector, is used as a proxy for balance sheet strength.

The model is estimated using Bayesian methods with a mixture of U.S. and Bahamian data. The U.S. data is used to estimate the financial frictions (interest rate spread, housing prices, bank leverage), with an emphasis on the 2007-09 period. The extent to which these financial shocks penetrated smaller open economies is then estimated through the use of Bahamian macro aggregate variables (consumption, investment, GDP deflator, 10-year Bahamian interest rate) from the period of 1996-2022. Our justification for using U.S. data to measure financial frictions in The Bahamas comes from the correlation between small open economies and U.S.-generated shocks [18].

We calibrate some parameters consistent with Smets-Wouters(2007). The depreciation rate of housing, δh, is calibrated as 0.1, greater than the depreciation rate of non-residential capital. The parameter ψ represents the weight on housing in the utility function and is chosen at 0.15. These two calibrated parameters pin down the steady-state residential investment-non-residential investment ratio at approximately 4:1. The parameter μ is the labour income share of the saving household, which is set at 0.75; the steady-state loan-tovalue ratio, m, is the ratio of the borrowing household and is chosen to be 0.75, consistent with US data.

The remaining parameters are estimated using Bayesian analysis. The priors are taken from Suh and Walker (2016) and are relatively standard in the literature. Tables 2 and 3 provide the prior and posterior results. The posterior values in parentheses come from using only U.S. data; that is, we assume that only U.S. data are used for the full estimation. The nonparentheses values represent Bahamian macro aggregates. Table 2 shows that the median and mean parameter estimates are roughly consistent across countries, whereas the 5-95 percentiles differ substantially. This is not surprising given that the model is linearised around a common steady state and given the correlation in U.S. and Bahamian data. Similarly, Table 3 shows little difference between US and Bahamian data in shock estimation.

Table 2: Prior and Posterior Distribution of Structural Parameters

Parameter	Description	Prior Distr.	Prior Mean	Prior St.Dev.	Posterior Median	Posterior Mean	5%	95%
φ	Non-residential capital adjustment cost	Normal	4.00	1.50	5.64 (6.13)	5.87 (6.16)	4.05 (4.37)	7.95 (7.91)
σc	Elasticity of intertemporal substitution	Normal	1.50	0.37	1.30 (1.31)	1.33 (1.32)	1.05 (1.11)	2.23 (1.54)
λ	Habit formation	Beta	0.70	0.10	0.87 (0.71)	0.87 (0.71)	0.56 (0.66)	0.92 (0.77)
ξw	Wage rigidity	Beta	0.50	0.10	0.90 (0.90)	0.90 (0.90)	0.84 (0.86)	0.96 (0.94)
σl	Labor elasticity	Normal	2.00	0.75	2.52 (2.14)	2.52 (2.16)	1.18 (1.23)	15.3 (3.07)
ξp	Price rigidity	Beta	0.50	0.10	0.65 (0.76)	0.65 (0.76)	0.59 (0.69)	0.75 (0.83)
ιw	Wage indexation	Beta	0.50	0.15	0.54 (0.55)	0.54 (0.55)	0.32 (0.34)	0.75 (0.77)
ιp	Price indexation	Beta	0.50	0.15	0.35 (0.24)	0.36 (0.25)	0.10 (0.10)	0.56 (0.39)
ψ	Capital utilization	Beta	0.50	0.15	0.70 (0.69)	0.69 (0.68)	0.45 (0.51)	0.88 (0.85)
φ	Fixed cost in production	Normal	1.25	0.12	1.54 (1.54)	1.55 (1.54)	1.35 (1.42)	1.75 (1.67)
rπ	MP reaction to inflation	Normal	1.50	0.25	1.53 (1.52)	1.54 (1.52)	1.05 (1.36)	1.85 (1.69)
rY	MP rigidity	Beta	0.75	0.10	0.80 (0.79)	0.80 (0.79)	0.76 (0.75)	0.83 (0.83)
rΔY	MP reaction to output gap	Normal	0.12	0.05	−0.01 (−0.01)	−0.01 (−0.01)	−0.04 (−0.02)	0.00 (0.00)
rΔY	MP reaction to output gap change	Normal	0.12	0.05	0.10 (0.15)	0.10 (0.15)	0.08 (0.11)	0.25 (0.18)
π*	Steady-state inflation	Gamma	0.62	0.10	0.83 (0.83)	0.83 (0.83)	0.67 (0.66)	0.99 (1.00)
δ	Steady-state discount rate	Gamma	0.25	0.10	0.27 (0.29)	0.29 (0.30)	0.15 (0.15)	0.44 (0.46)
$\bar{l}$	Steady-state hours worked	Normal	0.00	2.00	−2.37 (−2.32)	−2.37 (−2.34)	−5.65 (−4.46)	−0.01 (−0.14)
γ	Steady-state trend growth rate	Normal	0.40	0.10	0.25 (0.40)	0.25 (0.40)	0.02 (0.36)	0.54 (0.45)
α	Capital share in production	Normal	0.30	0.05	0.12 (0.17)	0.12 (0.17)	0.08 (0.14)	0.29 (0.26)
φh	Residential capital adjustment cost	Normal	0.30	0.05	0.25 (0.30)	0.25 (0.30)	0.20 (0.25)	0.39 (0.35)
σh	Elasticity, consumption and housing	Normal	1.50	0.37	1.23 (1.23)	1.25 (1.24)	1.08 (1.07)	1.41 (1.40)
πh*	Steady-state housing price inflation	Normal	0.20	0.15	0.20 (0.20)	0.20 (0.20)	0.11 (0.11)	0.30 (0.30)
χf	Financial accelerator	Normal	0.05	0.02	0.0004 (0.0004)	0.0004 (0.0004)	−0.002 (−0.002)	0.009 (0.009)
χTD	Interbank rate elasticity to DTD	Normal	0.05	0.02	−0.01 (−0.02)	−0.01 (−0.02)	−0.04 (−0.06)	0.02 (0.02)
χDTD,K	DTD elasticity to return on capital	Normal	0.05	0.02	0.02 (0.02)	0.02 (0.02)	0.00 (0.00)	0.03 (0.03)
χDTD,H	DTD elasticity to housing price	Normal	0.05	0.02	0.04 (0.05)	0.04 (0.05)	0.02 (0.03)	0.06 (0.07)

Table 3: Prior and Posterior Distribution of Shock Processes

Prior Distribution					Posterior Distribution			
		Distr.	**Mean**	**St.Dev.**	**Median**	**Mean**	**5 pct**	**95 pct**
σa	SE, productivity	Invgam	0.10	2.00	0.42(0.42)	0.42(0.42)	0.38(0.38)	0.46(0.46)
σb	SE, discount factor	Invgam	0.10	2.00	0.35(0.35)	0.35(0.35)	0.30(0.30)	0.40(0.40)
σg	SE, government	Invgam	0.10	2.00	0.46(0.46)	0.46(0.46)	0.41(0.41)	0.50(0.50)
σI	SE, investment	Invgam	0.10	2.00	0.34(0.34)	0.34(0.34)	0.27(0.27)	0.40(0.40)
σr	SE, monetary	Invgam	0.10	2.00	0.22(0.23)	0.23(0.23)	0.20(0.20)	0.25(0.25)
σp	SE, inflation markup	Invgam	0.10	2.00	0.13(0.13)	0.13(0.13)	0.11(0.11)	0.16(0.16)
σw	SE, wage markup	Invgam	0.10	2.00	0.29(0.29)	0.29(0.29)	0.25(0.25)	0.33(0.33)
σirs	SE, interbank spread	Invgam	0.10	2.00	0.06(0.06)	0.06(0.06)	0.06(0.06)	0.07(0.07)
σdtd	SE, distance to default	Invgam	0.10	2.00	0.19(0.18)	0.19(0.19)	0.17(0.17)	0.21(0.20)
σrp	SE, risk premium	Invgam	0.10	2.00	0.09(0.09)	0.09(0.09)	0.08(0.08)	0.10(0.10)
σnw	SE, net worth	Normal	3.00	0.50	2.10(2.11)	2.11(2.12)	1.89(1.89)	2.33(2.34)
σah	SE, housing invest-ment	Normal	3.00	0.50	2.07(2.07)	2.08(2.08)	1.84(1.84)	2.32(2.30)
σh	SE, housing de-mand	Normal	5.00	1.00	5.19(5.18)	5.20(5.20)	4.54(4.53)	5.86(5.86)
ρa	AR(1), produc-tivity	Beta	0.50	0.20	0.97(0.97)	0.97(0.97)	0.96(0.96)	0.99(0.99)
ρb	AR(1), discount factor	Beta	0.50	0.20	0.39(0.39)	0.40(0.39)	0.22(0.22)	0.57(0.56)
ρg	AR(1), government	Beta	0.50	0.20	0.97(0.97)	0.96(0.96)	0.94(0.94)	0.99(0.99)
ρI	AR(1), investment	Beta	0.50	0.20	0.83(0.83)	0.83(0.83)	0.78(0.77)	0.89(0.88)
ρr	AR(1), monetary	Beta	0.50	0.20	0.13(0.13)	0.13(0.13)	0.04(0.03)	0.22(0.23)
ρp	AR(1), inflation markup	Beta	0.50	0.20	0.92(0.92)	0.91(0.92)	0.86(0.86)	0.98(0.98)
ρw	AR(1), wage markup	Beta	0.50	0.20	0.88(0.86)	0.88(0.81)	0.61(0.61)	0.97(0.97)
ρirs	AR(1), interbank spread	Beta	0.50	0.20	0.70(0.74)	0.70(0.73)	0.58(0.60)	0.82(0.88)
ρdtd	AR(1), distance to default	Beta	0.50	0.20	0.98(0.98)	0.98(0.98)	0.96(0.96)	0.99(0.99)
ρrp	AR(1), risk pre-mium	Beta	0.50	0.20	0.96(0.96)	0.96(0.96)	0.94(0.95)	0.98(0.98)
ρnw	AR(1), net worth	Beta	0.50	0.20	0.43(0.43)	0.44(0.44)	0.27(0.28)	0.60(0.60)
ρah	AR(1), housing investment	Beta	0.50	0.20	0.97(0.97)	0.97(0.97)	0.95(0.95)	0.99(0.99)
ρh	AR(1), housing demand	Beta	0.50	0.20	0.97(0.97)	0.97(0.97)	0.95(0.95)	0.99(0.99)
µp	MA(1), inflation markup	Beta	0.50	0.20	0.80(0.81)	0.79(0.80)	0.68(0.69)	0.90(0.90)
µw	MA(1), wage markup	Beta	0.50	0.20	0.81(0.81)	0.77(0.76)	0.54(0.50)	0.95(0.96)
ρgy	Government spend-ing correlation	Beta	0.50	0.20	0.49(0.49)	0.50(0.49)	0.34(0.35)	0.64(0.64)

Note: The value in parentheses is using US data only.

Analysis of Results

The main takeaway of the paper is that macroprudential factors are important for understanding Bahamian macro aggregates. Macroprudential shocks, such as shocks to the discount factor, housing market and financial sector, are substantial drivers of welfare when the shock variances are calibrated to recessionary levels. It also suggested that outside of recessions, the standard shocks (e.g., productivity, monetary policy, investment specific shocks) drive the bulk of welfare. House price dynamics, banking sector risk premium and discount factor shocks also explain a majority of the variance decomposition of output and consumption. In comparing a macroprudential model vis-à-vis a model without macroprudential frictions, it was found that ignoring leverage ratios, risk premiums and the housing market leads to significant policy mistakes by policy makers. Specifically, the monetary authority is likely to over-tighten monetary policy—such as changes in leverage ratios, which can have an adverse effect on consumption and output—versus macroprudential changes.

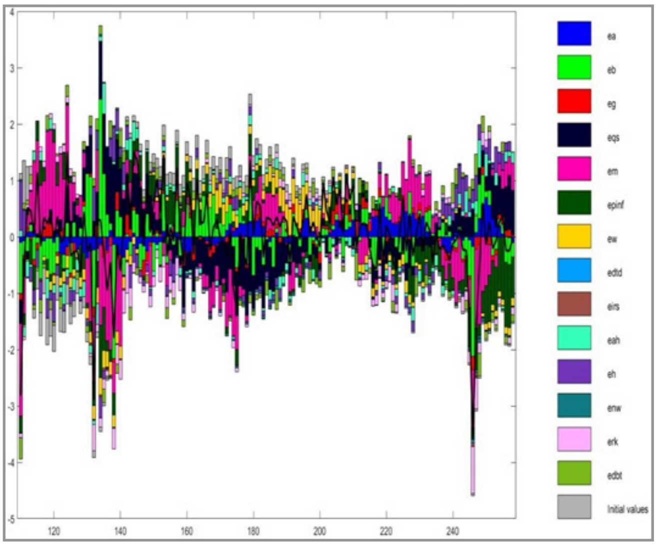


Figure 1: Historical Decomposition of Consumption

Figure 1 is a historical variance decomposition of consumption. It provides evidence for these facts by showing that discount shocks are most important for explaining consumption variation, especially during recessions or periods of negative consumption growth. Specifically, the figure demonstrates that the lion's share of variation in consumption can be attributed to discount factor shocks (eb), followed by shocks to the risk premium. Shocks to the interest rate also play an important role (em), especially during times of contraction. Not surprisingly, shocks to productivity and investment drive the historical decomposition of output (see Figure 2). However, during substantial drops, the discount factor shock again plays a significant role. This is because consumption contributes to output demand, and a substantial slowdown in consumption parleys into a drop in output the following quarter.

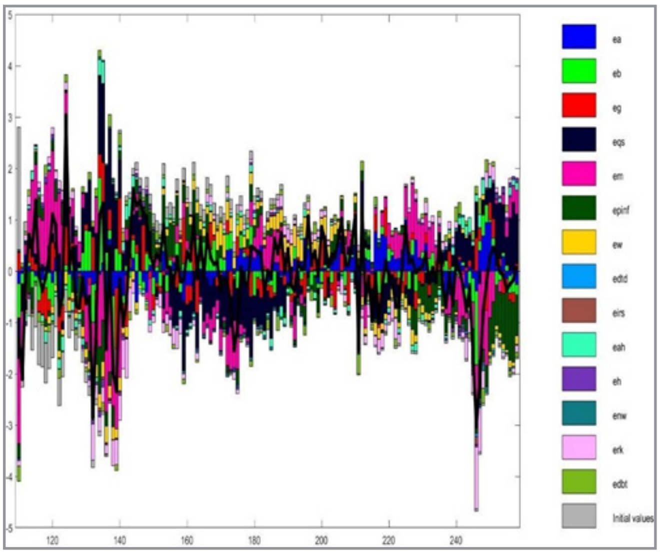


Figure 2: Historical Decomposition of Output

The economic intuition behind these financial frictions is as follows. In examining financial friction, an analysis of a standard deviation shock to the risk premium shows a rise in the entrepreneur's risk, as debt levels (entrepreneur leverage) deteriorate and the businessperson moves closer to a default level. In terms of the entrepreneur's net worth, a one standard deviation shock will decrease the business person's net worth, as risk spreads and leverage ratios decline, requiring more entrepreneurial assets to be devoted to servicing debt and reducing the distance-to-default ratio. Further, a one standard deviation shock to bank spread is likely to result in a narrowing in spreads, as banks become more profitable, and as the entrepreneur service levels increase. Concerning the distance to default, a shock will lead to a widening in the bank spread for the entrepreneur and their default distance. For all shocks originating outside of the financial sector, the bank spread and the default level will be mainly impacted, with a widening in spreads, and entrepreneurs are more likely to default.

Table 4: Variance Decomposition, Financial Variables (%)

Variables Shocks	Entrepreneur risk spread	Entrepreneur leverage	Interbank spread	Distance to default
Risk premium	90.5	25.1	0.9	2.7
Entrepreneur's net worth	5.6	43.4	0.7	0.1
Interbank spread	2.2	2.3	96.8	0.2
Distance to default	1.2	0.9	1.0	84.6
Non-financial	0.5	28.3	0.6	12.5

Table 5: Variance Decomposition, Non-Financial Variables (%)

Variables Shocks	ΔOutput	ΔConsumption	ΔInvestment	ΔInflation	ΔHousing Price	ΔHousing Investment
Productivity	5.7	3.7	1.8	9.7	0.2	1.0
Discount factor	11.6	35.0	0.2	0.5	1.2	1.0
Gvt. spending	10.9	1.4	0.0	1.3	0.3	0.5
Inv. specific	5.8	13.0	65.1	7.1	0.3	0.9
Monetary	11.7	14.8	5.1	2.5	8.1	14.2
Housing demand	15.2	1.4	0.8	18.8	30.0	64.9
Housing supply	10.5	1.0	0.1	0.2	58.8	12.0
Risk premium	3.9	1.8	10.2	6.8	0.1	0.2
Other financial	0.2	0.1	0.5	0.6	0.0	0.0

Variance decompositions show how much a shock contributes to the forecast error variance of each variable. We use variance decomposition to understand the importance of each financial friction channel in the model. Tables 4 and 5 present the variance decomposition of financial and non-financial variables at the posterior mean.

Tables 4 and 5 report forecast error variance decompositions for financial and non-financial variables at the posterior mean. In Table 4, we focus on the contribution of financial shocks (risk premium, net worth, interbank spread and distance-to-default) to the variance of financial indicators. By construction, the shares in this table sum to 100%, since we restrict attention to this subset of shocks and treat all other innovations as negligible for these particular variables. The results show that the risk premium shock is the dominant driver of entrepreneurial risk spreads, while movements in net worth account for a significant fraction of variation in leverage. Interbank spread shocks almost entirely explain the variance of the interbank spread itself, and distance-to-default shocks are the primary source of fluctuations in the DTD measure.

Table 5 shows that the discount factor shock accounts for the largest share of the change in consumption. Investment-specific shocks are most important for understanding business cycle dynamics as they account for 26.3% of output and 65% of investment. Housing services play a crucial role in explaining the variance of output.

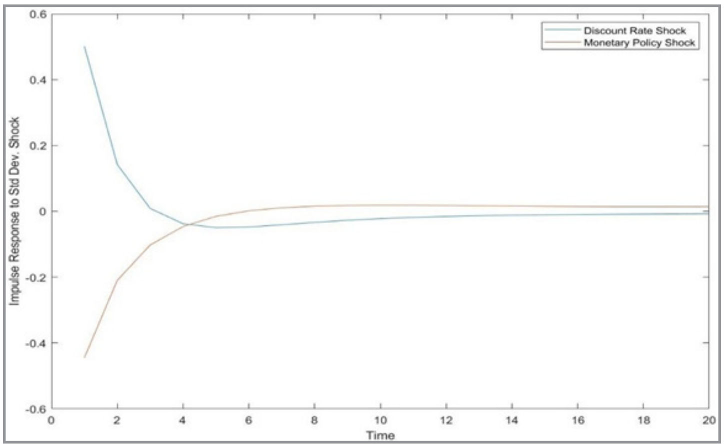


Figure 3: Impulse Response of Consumption to Discount Rate and Monetary Policy Shock

Figure 3 illustrates the impulse response of consumption to two different shocks: a contractionary monetary policy (discount rate) shock and a contractionary discount factor (intertemporal preference) shock. The first involves an unexpected rise in the central bank's policy rate, while the second reflects a decline in households' willingness to save compared to consuming today. Although their economic meanings differ, the model shows that consumption responds similarly over an eight-quarter period. In our baseline calibration, the policy rate shock has a slightly smaller standard deviation (0.22 versus 0.35), indicating that policy is not entirely ineffective. Instead, the findings imply that shocks to intertemporal preferences—affecting savings and credit conditions—are as significant as traditional policy rate shocks in influencing consumption. Coupled with the limited impact of policy shocks on credit spreads and leverage in the model, this supports our conclusion that standard interest rate policy has a relatively weak pass-through in the Bahamian context. Figure 4 plots the impulse response of output to a housing investment (supply side) and a housing demand shock. Both shocks have relatively large impacts on output. This is due to the estimated elasticity between housing and consumption (1.25). The initial increase to a positive shock is due to the fraction of output attributable to the housing stock. The subsequent decline, while modest, is due to the over-investment in periods 1-5. Households that work in the housing sector take more leisure time after the positive shock, leading to a decline in housing supply. This increases the price of housing, leading to a decline in housing demand beginning in period 8.

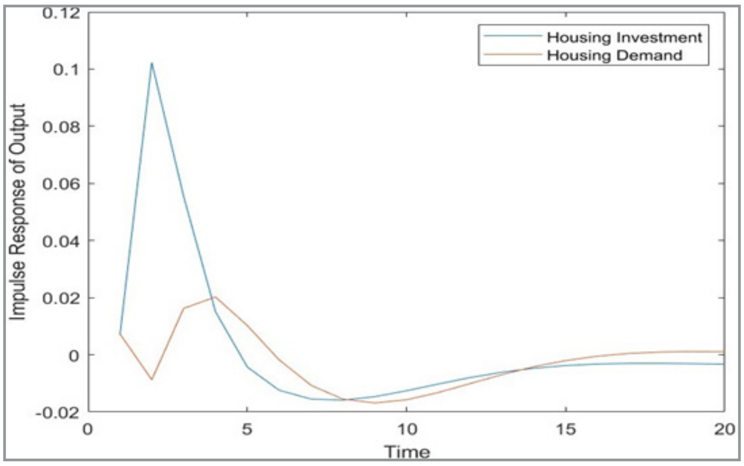


Figure 4: Impulse Response of Output to Housing Investment and Demand Shocks

The study also examines how different non-financial shocks contribute to fluctuations in output, consumption, investment, inflation and housing variables. Table 6 reports the percentage share of each shock in the forecast error variance of these variables, evaluated at the posterior mean using a second-order approximation of the model. This is not a full welfare analysis in the sense of optimising over policy rules; rather, it is a diagnostic that indicates which shocks are most important for volatility in the variables that enter households' utility. For example, a negative productivity shock leads to a decline in output and consumption and an increase in inflation. In contrast, a government spending shock modestly lowers output and consumption but raises inflation. A monetary policy shock and a risk premium shock both generate sizeable movements in investment and inflation, whereas housing demand and housing supply shocks play a prominent role in housing inflation and housing investment. These patterns help interpret variance decompositions in terms of the underlying economic trade-offs policymakers face [19].

Table 6: Welfare Effect of Non-Financial Variables (%)

Variable Shocks	Δ Output (Priors)	Δ Output (Posterior)	Δ Consumption (Priors)	Δ Consumption (Posterior)	Δ Investment (Priors)	Δ Investment (Posterior)	Inflation (Priors)	Inflation (Posterior)	Housing Inflation (Priors)	Housing Inflation (Posterior)	Δ Housing Investment (Priors)	Δ Housing Investment (Posterior)
Productivity	9.5	8.7	4.5	3.9	1.5	1.5	19.8	19.5	0.4	0.3	1.4	1.3
Discount Factor	11.7	11.7	26.6	26.4	0.9	0.9	0.8	0.8	1.1	1.1	1.6	1.7
Govt. Spending	10.9	10.7	1.7	1.7	0.0	0.0	3.0	2.8	0.3	0.3	0.8	0.8
Investment	22.3	22.8	11.7	12.1	65.0	64.4	7.3	7.6	0.2	0.2	1.0	1.1

Policy Rate	21.3	21.0	24.0	23.6	8.2	8.0	1.9	1.9	8.7	8.7	18.6	18.6
Inflation Markup	11.4	11.7	12.7	12.9	8.4	8.5	33.3	32.8	0.3	0.4	2.2	2.3
Housing Demand	0.2	0.2	4.5	4.6	0.2	0.2	4.7	4.5	25.6	25.3	64.4	64.1
Housing Supply	1.2	1.1	2.0	2.0	0.1	0.1	0.7	0.7	62.3	62.6	8.2	8.2
Risk Premium	6.9	7.6	5.0	5.7	13.6	14.3	8.5	9.7	0.1	0.2	0.4	0.5
Other Financial	2.6	2.5	5.0	4.8	0.5	0.5	0.4					

Source: Authors' Estimates

Policy Implications and Conclusion

Policy Implications

Indications are that this paper is the first to estimate a DSGE model with Bahamian data. The model introduces many non-standard, financial frictions that the data suggest are important for understanding consumption, investment and output in The Bahamas. The weak pass- through effects of monetary policy are observed in the results. For example, the impact of a monetary policy shock is on par with a shock to the discount factor. This would not be the case if monetary policy had substantial pass-through effects.

Output has a significant response to the housing market and related shocks, as shown by the variance decomposition results and impulse response functions. Macroprudential regulation, as opposed to more standard policy action, has an outsized impact on Bahamian macro aggregates.

Importantly, Table 6 further corroborates the main thesis of the paper, that non-standard shocks are most important in understanding welfare, with the discount factor explaining the largest change in welfare. These shocks are typically excluded in standard New Keynesian models. The results suggest that the financial sector is an integral part of the Bahamian economy and should be modelled.

Conclusion

The key findings of this study indicate that macroprudential indicators and macroprudential shocks are important considerations for understanding the dynamics of the Bahamian economy, and drivers of welfare ex-ante and ex-post recessionary periods. This conclusion is underpinned by the decomposition of consumption, which reveals that discount shocks are the main driver for variation in consumption, especially during periods of recession or negative consumption growth, while standard shocks drive the historical decomposition of output. Also of note, is the large impact on consumption from discount rate shocks and those that impact the saving/consumption decision.

Moreover, comparing a model with macroprudential frictions to one without revealed that the latter leads to "policy mistakes", thereby reinforcing the importance of macroprudential indicators for macroeconomic analysis and monetary authority policymaking.

References

1. Adolfson, M., Laséen, S., Lindé, J., & Vilani, M. (2007). Bayesian estimation of an open economy DSGE model with incomplete pass-through. Journal of International Economics, 72(2), 481–511. https://doi.org/10.1016/j.jinteco.2007.01.003
2. Alexander, W., Baliño, T. J. T., & Enoch, C. (1996). Adopting indirect instruments of monetary policy. International Monetary Fund. Finance & Development.
3. Bernanke, B. S., Gertler, M., & Gilchrist, S. (1996). The financial accelerator and the flight to quality. Review of Economics and Statistics, 78(1), 1–15. https://doi.org/10.2307/2109844
4. Bernanke, B. S., Gertler, M., & Gilchrist, S. (1999). The financial accelerator in a quantitative business cycle framework. In J. B. Taylor & M. Woodford (Eds.), Handbook of macroeconomics (Vol. 1, pp. 1341–1393). Elsevier. https://doi.org/10.1016/S1574-0048(99)10034-X
5. Crosbie, P., & Bohn, J. (2003). Modeling default risk. Moody's KMV Company.
6. Cormun, V., & De Leo, P. (2020). Stocks and exchange rates in small open economies (Working paper).
7. Faia, E., & Monacelli, T. (2008). Optimal monetary policy in a small open economy with home bias. Journal of Money, Credit and Banking, 40(4), 721–750. https://doi.org/10.1111/j.1538-4616.2008.00130.x
8. Francis, C. (1986). Monetary policy in a small, open, dependent economy: The case of the Bahamas. In Proceedings of the XVII Regional Monetary Studies Conference, Nassau, Bahamas.
9. Galí, J., & Monacelli, T. (2005). Monetary policy and exchange rate volatility in a small open economy. Review of Economic Studies, 72(3), 707–734. https://doi.org/10.1111/j.1467-937X.2005.00349.x
10. Gertler, M., Gilchrist, S., & Natalucci, F. M. (2007). External constraints on monetary policy and the financial accelerator. Journal of Money, Credit and Banking, 39(2–3), 295–

330. https://doi.org/10.1111/j.1538-4616.2007.00009.x
11. Kitano, S., & Takaku, K. (2018). Capital controls, monetary policy, and balance sheets in a small open economy. Economic Inquiry, 56(2), 859–874. https://doi.org/10.1111/ecin.12527
12. Kiyotaki, N., & Moore, J. (1997). Credit cycles. Journal of Political Economy, 105(2), 211–248. https://doi.org/10.1086/262072
13. Lee, J., & Rhee, W. (2013). Financial factors in the business cycle of a small open economy: The case of Korea. Open Economies Review, 24(5), 881–900. https://doi.org/10.1007/s11079-012-9270-6
14. Merton, R. C. (1974). On the pricing of corporate debt: The risk structure of interest rates. Journal of Finance, 29(2), 449–470. https://doi.org/10.2307/2978814
15. Shah, A., Singh, M., & Aggarwal, N. (2023). Distance to default: Implementation in R. Retrieved from https://rdrr.io/rforge/ifrogs/f/inst/doc/dtd.pdf
16. Smets, F., & Wouters, R. (2003). An estimated dynamic stochastic general equilibrium model of the euro area. Journal of the European Economic Association, 1(5), 1123–1175. https://doi.org/10.1162/154247603770383415
17. Smets, F., & Wouters, R. (2007). Shocks and frictions in U.S. business cycles: A Bayesian DSGE approach. American Economic Review, 97(3), 586–606. https://doi.org/10.1257/aer.97.3.586
18. Suh, H., & Walker, T. (2016). Taking financial frictions to the data. Journal of Economic Dynamics and Control, 64, 39–65. https://doi.org/10.1016/j.jedc.2015.12.006
19. Vasicek, O. A. (1984). Credit cycles. KMV Corporation.

Appendix A: Derivation of Equilibrium Equations

Detrending

For detrending purposes, we define new variables such as: $\xi t=\Xi t/\gamma-\sigma ct, ht=Ht/\gamma t, kt=$□ □$t/\gamma t, kth=Kth/\gamma t, ct=Ct/\gamma t, wt=Wt/(Pt\gamma t), \bar{\beta}=\beta\cdot\gamma-\sigma c, \bar{\beta}'=\beta'\cdot\gamma-\sigma c$, where Ξt is the Lagrange multiplier with regard to the budget constraint. Then the first order conditions of patient households are

The first order conditions of impatient household are

where we define Λt as the Lagrange multiplier with regard to debt constraint and Ωt as the ratio of Lagrange multipliers, $\Omega t\equiv\Lambda t/\Xi$□

In housing goods producer's problem, the law of motion for housing can be written as

and the optimality condition is

Steady State

The following describes the steady-state of the economy with respect to the variables in the housing market. Since housing goods can be transformed from consumption goods with no cost, the steady state price of housing goods in terms of consumption goods is 1. From the first-order condition, we obtain

and

Define $Y\equiv1-i\ y-g$, we obtain

For the housing production side,

Also, from impatient households' budget constraint,

Log-linearization Around the Steady State

In the following text, log-linear variables are denoted by hat. Marginal utility of consumption is

where $j\hat{}t$ is defined by

Note $L1+\sigma l$ can be written as

The first-order condition becomes

and

The budget constraint of the borrowing household becomes

and LTV constraint becomes

Law of motion for the gross housing goods and the optimality condition for the housing goods producing firms are given by

Aggregate resource constraint is given by

Regarding the financial frictions in the business sector, the marginal productivity of capital □ □ˆt is given by

where $w\hat{}ta$ is the weighted average real wage of the patient and the impatient household. Then the return on capital is defined by

where $q\hat{}t$ is the price of capital. Given this definition of return on capital, the log-linear form of the financial accelerator equation is

where χe is the parameter that represents the elasticity of the external finance premium with regard to the entrepreneur's net worth. The law of motion for the entrepreneur's net worth is

Regarding the financial friction for the financial intermediary sector, we have the relationship between the bank spread and the distance-to-default,

and the relationship between the bank distance-to-default and the expected housing price and capital price,

Other equilibrium conditions

Non-financial friction, part of the SW-FF model, is similar to the SW model. The production function of the economy is given by

and non-residential capital service is defined by

where $k\ \hat{}\ t\ p$ is physical capital stock and $u\hat{}t$ is utilization rate. The following relationship exists between the marginal cost of production and the wage and marginal productivity of capital,

Law of motion for the physical capital stock is given by

where δ is the depreciation rate. From the optimality condition for the capital utilisation, we have the relationship between the marginal productivity of capital and the level of utilisation,

Capital producer's first order condition with regard to investments gives us the following optimality condition

There is a Calvo type of nominal rigidity in intermediate goods production, as only a certain fraction of intermediate good producers can choose the optimal sales price. The price of producers who cannot optimise is partially indexed to the past inflation. Optimisation by price-setting producers leads to the following New Keynesian Phillips curve,

where ιp,ξp,ϵp are the degree of indexation to past inflation, the degree of price stickiness, and the curvature of Kimball goods market aggregator. Also, the markup in the intermediate goods production $\mu\hat{}t\ p$ equals

There is also nominal rigidity in wage decisions, as only a fraction of labour unions can optimally reset nominal wages, and the other fraction only partially index their wage to the past wage. Optimality conditions lead to the expression for the real wage for patient and impatient households,

where ιw,ξw,ϵw are the degree of indexation to past wage, the degree of wage stickiness, and the curvature of the Kimball labour market aggregator. Also, the markups in the wage contract $\mu\hat{}tw$,$\mu\hat{}tw'$ equal

Monetary policy sets the nominal interest rate $r\hat{}tN$ in a way that reacts to inflation, output gap and changes in output gap. The output gap is defined by the difference between the current output ($y\hat{}t$) and the flexible-price, flexible-wage economy output ($y\hat{}t\ *$).

Regarding exogenous processes, productivity shock $\varepsilon\hat{}ta$, discount factor shock $\varepsilon\hat{}t\ \beta$, investment specific shock $\varepsilon\hat{}t\ i$, monetary policy shock $\varepsilon\hat{}tr$, lending stand shock $\varepsilon\hat{}tdbt$, firm net worth shock □ □$\hat{}tnw$, risk premium shock $\varepsilon\hat{}t\ rp$, bank spread shock $\varepsilon\hat{}tbs$, distance-to-default shock $\varepsilon\hat{}tdd$, housing demand shock $\varepsilon\hat{}t\ \psi$, housing supply shock $a\hat{}th$ follow AR(1) process. Government spending shock $\varepsilon\hat{}t\ g$ follows AR(1) process with a correlation with productivity shock. Inflation markup shock $\varepsilon\hat{}t\ p$ and wage markup shock $\varepsilon\hat{}tw$ follow ARMA (1,1) process.

Appendix B: Data

Definition of Bahamian Data (Source: Central Bank of The Bahamas)
Consumption = LN[(PCEC/GDPDEF)] × 100
Residential investment = LN[(FPIR/GDPDEF)/LNSindex] × 100
Output = LN(GDPC96/LNSindex) × 100
Hours = LN [(PRS85006023 × CE16OV/100)/LNSindex] × 100
Inflation = LN (GDPDEF/GDPDEF (-1)) × 100
Real wage = LN(PRS85006103/GDPDEF) × 100
Interest rate = 10-Year BGS rate /4
Definition of U.S. Data
Firm leverage = LN [(Firm Asset)/ (Firm Asset-Firm Debt)], demeaned
Distance to default = LN (Z-score Distance to Default)
Interest rate spread = (Federal Funds Rate - 1m Euro-Dollar Deposit Rate)/4
Risk spread = (Moody's BAA-10 Year Treasury Spread)/4 - Interest rate spread
Housing price = LN[(Housing Price Index/GDPDEF)/(Housing Price Index(-1)/GDPDEF(-1)] × 100