Contributions

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Financial Reforms and Consumption Smoothing

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Abstract: We study how financial reforms affect the extent of consumption smoothing in a dynamic stochastic general equilibrium model of an emerging economy. Consistent with the empirical literature and reform efforts in South Korea and South Africa, we emphasize the relation between consumer credit and durable purchases, and model reforms as the relaxation of the collateral constraint on lower income households. We find that the relaxation of the collateral constraint accounts for a substantial share of the decline in consumption smoothing experienced in South Korea and South Africa.

Keywords: home production, collateral constraint, durable, and consumption volatility

JEL Classifications: E21, E26, F41, F44

1 Introduction

We study how financial reforms affect the extent of consumption smoothing in a two-agent dynamic stochastic general equilibrium (DSGE) model of an emerging economy. In contrast to most of the literature, we focus our attention on the domestic component of financial reforms and their effects on household credit, durable purchases, and consumption smoothing. Our interest is motivated by the empirical literature that studies consumption smoothing in developing countries using micro data. In particular, both Aron and Muellbauer (2013) and

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Rosenzweig and Wolpin (1993) argue that credit constraints and the accumulation of durable physical assets, and their interplay, are important determinants of consumption behavior. Other relevant studies for developing economies include Karlan et al. (2014) and Kazianga and Udry (2006).[1]

Surprisingly, most of the financial reform literature focuses on the effects of international liberalization and globalization, notwithstanding that financial reforms mix both domestic and international components. In addition, the literature ignores the relation between credit and durables at the household level, even when studying emerging and developing economies. The main lesson from the empirical reform literature is that liberalization improves consumption smoothing in industrialized but not in emerging economies. For industrialized economies, Bekaert, Harvey, and Lundblad (2006) and Prasad et al. (2007) document that financial liberalization is associated with lower consumption volatility. For emerging economies, Bekaert, Harvey, and Lundblad (2006) find a much weaker association, while Prasad et al. (2007) document that consumption becomes more volatile. One possible reason is that, as Kose, Prasad, and Terrones (2009) argue, financial liberalization helps improve the extent of risk sharing for industrialized economies but not for emerging economies.

Spurred by these empirical findings, Bai and Zhang (2012), Bhattacharya and Patnaik (2016), Faia (2011), Leblebicioglu (2009), and Levchenko (2005) all study the effects of international financial reforms in DSGE models of emerging economies.[2] We depart from this literature by focusing on the domestic component of financial reforms and their effects on household credit, durable purchases, and consumption smoothing.

Unfortunately, very few emerging and developing economies report durable consumption expenditures for a long enough sample that covers a sizeable financial reforms. Of the emerging economies that enacted substantial financial reforms during the 1990s, only South Korea and South Africa report durable expenditures for a long period that predates the reforms. A review of the reform efforts in these two countries suggests a number of important takeaways. First, financial reforms were enacted over several years and combined both domestic and international components. Second, researchers that have specifically studied financial reforms in South Korea and South Africa interpret the reforms as important relaxation

1 There is also an important literature that links consumption behavior to credit constraints and durables in industrialized economies. Examples include Alessie, Devereux, and Weber (1997), Attanazio, Goldberg, and Kyriazidou (2008), and Chah, Ramey, and Starr (1995).

2 We also acknowledge a much larger literature that studies financial development and volatility, including Aghion, Bacchetta, and Banerjee (2004), Iyigun and Owen (2004), and Wang, Wen, and Xu (2016).

of a collateral constraint faced by consumers. Finally, consumption smoothing worsen in both economies after financial reforms.

For our analysis, we adopt a structural approach where we focus on a domestic reform that relaxes a collateral constraint faced by consumers. We rely on a structural approach because it permits us to distinguish the effects of the relaxation of the collateral constraint from other concurrent changes spurred either by the international component of the reform or by other unrelated changes. For this, we first construct a closed economy model that emphasizes the relation between credit constraint, durable assets, and consumption at the household level. We specifically choose a closed economy to emphasize the domestic component of financial reforms. We then embed our framework into a small open-economy model and attempt to gauge the importance of the domestic component of financial reforms in an environment that accommodates some aspects of the international component of financial reforms and potentially other unrelated changes.

Our closed economy model builds on the two-agent model of Kiyotaki and Moore (1997). In this model, the credit constraint that impedes risk sharing across different types of agents takes the form of a collateral constraint. In our version, lower income households have limited access to asset markets, while richer households have unlimited access to asset markets. Both types of households engage in the production of a tradable market good that requires capital and labor, and is subject to a productivity shock. In contrast to Kiyotaki and Moore (1997), our households also engage in nonmarket or home production, as in Benhabib, Rogerson, and Wright (1991) and Greenwood and Hercowitz (1991). Home production mirrors market production in that it requires capital and labor inputs and it is subject to a productivity shock. In our model, home production plays two key roles. First, the main source of idiosyncratic risk is home productivity shocks. This is the risk whose sharing across the two types of agents is impeded by the collateral constraint. Second, the main motivation to accumulate durable is that the stock of durable is the capital input to home production. Further, the home capital is the collateral asset of the poorer households, and this captures the role of durable physical assets discussed in the empirical micro data literature that studies consumption smoothing in developing countries.

More generally, our model relies on home production because it is quantitatively significant and accounts for several features relevant to our work. First, the empirical estimates reported in Eisner (1988) and Schneider and Enste (2000) suggest that home production might be valued to roughly 20 percent of measured gross domestic product. More importantly, several authors, including Chen, Chu, and Lai (2018), Gomme and Zhao (2010), and Restrepo-Echavarria (2014), follow Parente, Rogerson, and Wright (2000) and argue that home production is more prevalent in emerging and developing economies than in industrialized

economies. One potential explanation for this is that, as argued in Chen, Chu, and Lai (2018), households in emerging economies allocate more efforts to home production than households in industrialized economies because they use a home production technology that is more intensive in labor.

Second, home production help explains several features of the business cycle that are relevant for our study. In the closed economy context, Benhabib, Rogerson, and Wright (1991) and Greenwood and Hercowitz (1991) find that the willingness to substitute between market and home production, as well as the interplay between time use and the accumulation of home capital, provides a more complete picture of business cycle fluctuations in durable expenditures. Baxter and Jermann (1999) further show that the same willingness to substitute between market and home activities provides a more complete picture of the fluctuations of consumption. In the open economy context, Boileau (1996), Canova and Ubide (1998), and Karabarbounis (2014) all show that home production explains imperfect international risk sharing largely because fluctuations in home productivity shocks act as microfounded taste shocks. Finally, Chen, Chu, and Lai (2018), Gomme and Zhao (2010), and Restrepo-Echavarria (2014) all argue that fluctuations in home production, as well as the importance of home production, contributes to high consumption volatility in emerging economies.

We analyze the model using numerical simulations. The simulations reveal that relaxing the poorer households' collateral constraint produces a hump shaped response in the relative volatility of consumption. When the households are highly constrained, a relaxation raises the volatility of both durable and nondurable consumption. This higher volatility translates to the relative volatility of aggregate consumption as long as a large share of the population faces the collateral constraint and has no access to the equity market. In addition, these effects are quantitatively more important when home production itself is more important. This suggests that a deterioration of consumption smoothing following reforms is more likely in emerging economies, where equity markets are less developed and where home production plays a larger role than in industrial economies.

We then insert the main framework into a small open-economy model to gauge the importance of this channel. The small open economy version summarizes international financial markets in an interest rate equations that has variations in world interest rate and country-specific spread, as in Alvarez-Parra, Brandao-Marques, and Toledo (2013), Chang and Fernandez (2013), Garcia-Cicco, Pancrazi, and Uribe (2010), Neumeyer and Perri (2005), and Uribe and Yue (2006). Our approach then is specific about the domestic component of the reform, but much less so about the international component because those are embedded in the international interest rate equation. We calibrate the resulting version of the model to replicate the standard business cycle statistics for a pre-reform period

and a post-reform period in both South Korea and South Africa. The calibration exercise reveals that a sizeable relaxation of the collateral constraint is required to match the business cycle statistics between the two periods.

The rest of the paper is organized as follows. Section 2 briefly reviews the experience of South Korea and South Africa. Section 3 presents the closed economy model and discusses some of its implications. Section 4 discusses the numerical solution and the effects of financial reforms on consumption smoothing in the closed economy. Section 5 extends the model to the open economy. Section 6 concludes.

2 Reforms in South Korea and South Africa

Our novel interpretation of the effects of financial reforms relies on the collateral role of consumer durable in emerging economies. Unfortunately, very few countries report durable consumption expenditures for a long enough sample that covers a sizeable financial reform. As an example, the data in Alvarez-Parra, Brandao-Marques, and Toledo (2013) generally starts in mid to late 1990s, precisely during the early 1990s wave of financial reforms for emerging economies (see Abiad, Detragiache, and Tressel, 2010). Fortunately, both South Korea and South Africa provide annual data on durable expenditures for a sample that overlap their major financial reforms.

Our discussion proceeds in two steps. We first provide a brief review of the financial deregulation efforts for both countries. Our most important take away from this review is that researchers that have specifically studied financial reforms in South Korea and South Africa interpret the reforms as important relaxation of a collateral constraint faced by consumers. This is the emphasis explored in our closed economy model. A second take away is that financial reforms were enacted over several years and included both more domestic and more international components. This highlights difficulties in interpreting recent empirical work that rely on exact dating of reforms. We then present business cycle statistics for periods before and after financial reforms in both countries. The important take away here is that consumption smoothing did not improve after the reforms.

2.1 A Review of Financial Reforms in South Korea and South Africa

We are interested in the financial deregulation that occurred in the early to mid 1990s in South Korea and South Africa. In both cases, the deregulations included

both domestic and international components and were spread out over several years. In South Korea, the financial deregulation followed a three-phase plan that was to be implemented between 1993 and 1997. In South Africa, the financial deregulation came with the dismantlement of apartheid that occurred between 1990 and 1996.

At the same time, South Korea and South Africa differ greatly. In the mid 1990s, South Korea had low unemployment and low income inequality, while South Africa had high unemployment and high income inequality. For South Korea, Kang (2001) reports a 1993 unemployment rate of roughly 3 percent and a Gini coefficient of roughly 30 percent. For South Africa, Aron and Muellbauer (2000) report a 1993 broad unemployment rate somewhere between 30 and 40 percent and a Gini coefficient of more than 60 percent. Another important difference is the extremely poor access to banks and credits in early 1990s South Africa. Ludwig (2008) reports that 60 percent of adults did not have access to banks or credits in 1994, while Okurut (2006) estimates that almost 90 percent of households did not have access to credits in 1995.

2.1.1 South Korea

Park (1996) provides an overview of South Korea's experience with financial deregulation. For a broader perspective, Bekaert and Harvey (2005) provide a detailed chronology of financial deregulations and other important economic events, while Soon (1995) provides a narrative of the different reforms.

In the 1960s and 1970s, Korea's government supported its export-led growth policy by directly intervening in financial markets. In particular, the government would issue lending directives to redirect credit toward exporting industries, while charging below market lending rates. Eventually, overinvestment in particular industries and an episode of stagflation in the late 1970s prompted a reevaluation of Korea's economic policies. The new policy package included financial market reforms.

Korea's deregulation of domestic financial markets was very gradual. The government deregulated lending rates progressively over the 1980s but some of these were reversed because of economic slowdowns at the end of the 1980s. In 1993, Korea announced a three-phase blueprint for financial deregulation. The blueprint called for both domestic and international liberalization. Importantly, the first phase (1993–94) involved a deregulation of all bank and nonbank lending rates, while the latter two phases called for further domestic and then international liberalization. Unfortunately, deregulation efforts in Korea were followed by a massive foreign exchange crisis in 1997.

Deregulation efforts were also followed by large changes in household debt. Park (2009) reviews changes in household debt for the 1998–2002 period that just followed the crisis. Interestingly, households in the lower quintiles of the income distribution saw large increase in household debt, while households in the upper quintiles saw no change or even a reduction in household debt. In particular, households in the second and third lowest quintiles of the income distribution experienced a 41 percent and 32 percent increase in their average household debt. Households in the second top quintile did not experience much change in their household debt, while households in the top quintile experienced a seven percent drop in average household debt. Park (2009, p.169) argues that this is indicative of a relaxation of the collateral constraint for poor households:

> "First of all, we can argue that the results provide indirect evidence for alleviation of credit constraints in the consumer credit market. The fact that lower-income households experienced faster debt accumulation may imply the alleviation of severe liquidity constraint placed on them under the practices prevailing in the financial market before the economic crisis. Before the economic crisis, direct intervention of the government in credit allocation was a common practice. The Korean government pursued the development policy to channel a disproportionately large amount of credit resources into a small group of targeted industries to promote faster growth. It was not rare that households were not able to borrow even though they did possess enough assets to offer as collateral in some cases, let alone borrowing without collateral. After the economic crisis in 1997, the Korean government gave up the traditional interventionist approach and let the market determine resource allocation in the credit market. It was then possible for financial institutions to increase the credit supply to the household sector with less concern about non entrepreneurial factors."

2.1.2 South Africa

Aron and Muellbauer (2000, 2013) summarize South Africa's experience with financial deregulations. Both Bekaert and Harvey (2005) and Muyambiri and Odhiambo (2014) provide a detailed chronology of financial deregulations.

Deregulation efforts in South Africa have some similarities with the efforts in Korea. For example, in the 1960s and 1970s, South Africa pursued government led development and intervened heavily in financial markets. Eventually, rising inflation and pressures on the South African rand prompted a reevaluation of South Africa's financial and monetary policies.

This reevaluation appears in the reports of the Commission of Inquiry into the Monetary System and Monetary Policy of South Africa (the de Kock Reports) that appeared as interim reports in 1978 and 1982, and a final report in 1985. Amongst other policy recommendations, the reports advocate a deregulation of

financial markets. As discussed in Aron and Muellbauer (2013) and Muyambiri and Odhiambo (2014), South Africa removed its interest and credit controls, as well as the implemented other financial reforms, in the early 1980s. Broader financial reforms were slowly instituted over time.

For our purpose, we are interested in the dismantling of apartheid that occurred between 1990 and 1996. Of particular interest is the Abolition of Racially Based Land Measures Act of 1991 that abolished restrictions on land ownership. This act is important because race-based land restrictions effectively eliminated the possibility of non-white consumers to pledge land as a collateral. Aron and Muellbauer (2013) study the importance of the collateral effect of housing wealth and financial reforms on consumption in South Africa. On collateral, they argue that, in the early 1990s, pensions were the main collateral in housing loans, while in the mid 1990s special mortgage accounts allowed consumers to borrow using the value of housing as the collateral. Aron and Muellbauer (2013, p. S193) conclude:

> "Estimates from this model on aggregate data when there is certainly great heterogeneity of behavior at the micro-level need to be interpreted with care. For example, the estimated housing collateral effect after credit market liberalization for South Africa is estimated to be about twice or more as high as for the three Anglo-Saxon economies. The estimated effect is an average for a population with one of the highest levels of income inequality in the world and necessarily reflects a diverse set of micro-responses, zero for most households. It is plausible that the segments of the population where the responses are largest have been increasing their share of income and consumption. The growth of a Black South African middle-class, with low saving deposits but improving employment opportunities and confident expectations in future income, has likely led to an increase in spending linked to easier credit and higher collateral values, accounting for the large collateral effect. However, as noted above, the AIDS epidemic may well have caused a partial reversal of these tendencies from the late 1990s."

Aron and Muellbauer (2013) acknowledge that some of the financial deregulation that accompanied the dismantlement of apartheid can be interpreted as a loosening of a collateral constraint on consumers. They also acknowledge however that few households had access to credits (a large fraction were unbanked). It may also be that the growth of a black middle-class should rather be interpreted has gaining access to a much wider array of financial services, and this should be interpreted as also gaining access to securities market.[3]

3 We must also consider two other events. First, the advent of microloans that occurred in the mid 1990s should help consumers smooth consumption and acquire durable. The empirical evidence, however, is that these loans were not used to purchase durable. For example, Hurwitz and Luiz (2007) document that, amongst the urban working class, microloans are mostly used

2.2 Pre and Post Reform Business Cycle Moments

Table 1 displays standard business cycle moments for South Korea and South Africa before and after financial deregulations. The annual data is detailed in the Data Appendix. The whole sample covers the period 1970 to 2019 for South Korea and the period 1960 to 2019 for South Africa. For this exercise, dating the reform is somewhat difficult because it occurred over a long period. For Korea, the reform that concerns us started in 1993 and progressed at least until 1996, and was followed by the Asian financial crisis.[4] To avoid any confusion, we simply remove the period from 1993 to 2000 from the data. Thus, our pre reform data includes data up to and including 1992, while our post reform data includes data after and including 2000.[5] For South Africa, we are interested in the dismantling of apartheid that occurred between 1990 and 1996, we consider the pre-reform period to extend to 1990 and the post reform period to start in 1996. Finally, the observed moments are computed on the cyclical components extracted by the HP filter using a smoothing parameter of 100 for each period, except for net exports (see Hodrick and Prescott 1997).

A comparison of the pre and post-reform moments shows a sizeable increase in the relative volatility of aggregate consumption and non-durable consumption for South Korea and a more modest increase for South Africa. For durable consumption, the relative volatility rose considerably for South Korea, but declined slightly for South Africa.

These two economies experienced other changes in their business cycle. South Korea saw a large decline in the volatility and persistence of it is output.

for funerals, to pay off debt, for family emergencies, for education, and for transport. Bank loans are used more broadly, including for expenses related to housing, transport, and acquiring durable. Second, although difficult to quantify exactly, the AIDS epidemic must have force some households to devote growing fractions of their income to health related expenditures, and this should impede consumption smoothing. The AIDS epidemic must also have greatly reduced future income for some consumers, which should reduce the ability of some households to acquire loans.

4 We note that Bekaert and Harvey (2005) select 1992 as their reform date, while Park (1996) and Bhattacharya and Patnaik (2016) select 1996 as the capital account liberalization date.

5 The cutoff year of 2000 corresponds to the end of the recession caused by the Asian crisis according to the HP filter. Specifically, the year 2000 is the first post-Asian crisis year where the logarithm of real per capita GDP is not below trend. Our choice of the year 2000 also aligns with other aspects of the Asian crisis. For example, Oh and Rhee (2002) documents that the number and value of corporate defaults rose sharply in 1998 and 1999 but were back to pre-crisis levels by year 2000, while Choi (2017) shows that the yield spread between 3-year corporate bonds and 3-year treasury bonds rose rapidly in 1998, but was back to much lower levels by 2000 and remained so until the Great Recession in 2008.

Table 1: Business cycle moments.

	South Korea			South Africa		
	All	**Pre**	**Post**	**All**	**Pre**	**Post**
Volatility						
Output	2.80	3.35	1.08	1.94	1.95	1.59
Volatility relative to output						
Consumption	0.93	0.57	1.34	1.28	1.32	1.44
Nondurable	0.72	0.50	1.26	0.99	1.02	1.16
Durable	2.67	1.81	2.89	3.83	4.21	4.07
Investment	3.49	3.34	3.93	4.70	5.32	3.33
Net export ratio	0.87	0.52	1.56	1.89	1.89	1.20
Correlation with output						
Consumption	0.80	0.85	0.56	0.77	0.67	0.93
Nondurable	0.76	0.73	0.53	0.71	0.55	0.92
Durable	0.78	0.75	0.45	0.69	0.67	0.81
Investment	0.82	0.76	0.65	0.74	0.79	0.84
Net export ratio	−0.43	−0.17	0.04	−0.45	−0.46	−0.46
Autocorrelation						
Output	0.48	0.58	0.16	0.58	0.47	0.62
Net export ratio	0.72	0.74	0.74	0.83	0.74	0.78

Note: The numbers are moments computed on relevant detrended series. Volatility refers to the percent standard deviation, Volatility Relative to Output refers to the ratio of the standard deviation of a variable to the standard deviation of output, Correlation with Output is the correlation coefficient between a variable and output, and Autocorrelation to the first autocorrelation. Each relevant series is detrended with the HP filter with a smoothness parameter of 100, except for the net export to output ratio. For Korea, the whole sample (All) covers the 1970 to 2019 period, the pre-reform (Pre) sample extends from 1970 to 1993, and the post-reform sample (Post) extends from 2000 to 2019. For South Africa, the whole sample (All) covers the 1960 to 2019 period, the pre-reform sample extends from 1960 to 1990, and the post-reform sample extends from 1996 to 2019.

The decline in the volatility of output is notable and suggests that the rise in the relative volatility of consumption volatility did not come from more volatile income. At the same time, consumption and investment became much less procyclical, but net exports became much more volatile and slightly procyclical. South Africa saw a decline in the relative volatility of both investment and net exports.

Overall, these moments confirm that consumption smoothing worsened in both countries after the financial reforms. The pre and post-reform changes suggest that both countries must have experienced other changes in addition to their

financial deregulation. The role played by the domestic component of financial reforms will have to be clarified in the context of these other changes.

3 The Closed Economy Model

3.1 The Closed Economy

The economy is populated by two types of households, that we label r and u. Both types consume market and home produced goods. They engage in housework and supply labor to the market sector. Type r households are relatively more impatient and poorer than their u counterparts, they only have restricted access to asset markets. Type u households are more patient and wealthier, and they have unrestricted access to asset markets. We exogenously assign a fraction $(1-\omega)$ of the population to be of type r and a fraction ω to be of type u, and we normalize total population to one.

The households derive utility from the consumption of a composite good c_t^i, and disutility from working l_t^i, where $i = r$ or u:

$$E_0 \sum_{t=0}^{\infty} \beta_i^t u(c_t^i, l_t^i) \tag{1}$$

where $0 < \beta_i < 1$ is the subjective discount factor for households of type i and $u(c_t^i, l_t^i) = \ln[c_t^i - (\varsigma/(1+\nu))l_t^{i\,1+\nu}]$. In line with the empirical results in Becker and Mulligan (1997), the poorer type-r households are impatient relative to the wealthier type-u households: $\beta_r < \beta_u$.

The composite consumption good is given by

$$c_t^i = \left[\mu_i c_{\mathrm{m}t}^{i\,\frac{\varepsilon-1}{\varepsilon}} + (1-\mu_i) c_{\mathrm{h}t}^{i\,\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{2}$$

where $c_{\mathrm{m}t}^i$ and $c_{\mathrm{h}t}^i$ are consumption of market and home produced goods at time t by consumers of type i, $\varepsilon \geq 0$ is the elasticity of substitution between the two types of consumption goods, and $0 \leq \mu^i \leq 1$ measures the bias toward market goods. Hours worked l_t^i are allocated as follows

$$l_t^i = l_{\mathrm{m}t}^i + l_{\mathrm{h}t}^i \tag{3}$$

where $l_{\mathrm{m}t}^i$ and $l_{\mathrm{h}t}^i$ are time devoted to market and home work.

The home sector produces output $y_{\mathrm{h}t}^i$ using capital $k_{\mathrm{h}t}^i$ and labor $l_{\mathrm{h}t}^i$:

$$y_{\mathrm{h}t}^i = z_{\mathrm{h}t}^i \left(k_{\mathrm{h}t}^i\right)^{\alpha_{\mathrm{h}}} \left(l_{\mathrm{h}t}^i\right)^{1-\alpha_{\mathrm{h}}} \tag{4}$$

where $0 < \alpha_{\mathrm{h}} < 1$ denotes the capital share in home production and $z^i_{\mathrm{h}t}$ is total factor productivity (TFP). Home capital evolves as

$$k^i_{\mathrm{h}t+1} = \Phi\left(x^i_{\mathrm{h}t}/k^i_{\mathrm{h}t}\right) k^i_{\mathrm{h}t} + (1-\delta_{\mathrm{h}})k^i_{\mathrm{h}t} \tag{5}$$

where $x^i_{\mathrm{h}t}$ denotes investment made in home capital (or, similarly, purchases of household durable) at period t, $0 < \delta_{\mathrm{h}} < 1$ is a depreciation rate, and $\Phi\left(x^i_{\mathrm{h}t}/k^i_{\mathrm{h}t}\right) = x^i_{\mathrm{h}t}/k^i_{\mathrm{h}t} - (\phi/2)(x^i_{\mathrm{h}t}/k^i_{\mathrm{h}t} - \delta_{\mathrm{h}})^2$ implies investment adjustment costs, controlled by $\phi \geq 0$.

Home TFP follows a stochastic process described by

$$\ln(z^i_{\mathrm{h}t}/\bar{z}^i_{\mathrm{h}}) = \rho_i \ln(z^i_{\mathrm{h}t-1}/\bar{z}^i_{\mathrm{h}}) + \epsilon^i_{\mathrm{h}t} \tag{6}$$

where $\epsilon^i_{\mathrm{h}t}$ is a mean zero random variable with variance $\sigma^2_{\mathrm{h}} > 0$, $\bar{z}^i_{\mathrm{h}} > 0$ is the steady state value of home TFP, and $0 < \rho_i < 1$ denotes the persistence of the deviations of home TFP from its steady state value.

Finally, we note that home sector output is nonstorable and used only for consumption:

$$c^i_{\mathrm{h}t} = y^i_{\mathrm{h}t}. \tag{7}$$

Type-r households supply labor to firms against the market wage W_t. These households have restricted access to asset markets. In particular, they do not have access to the equity market, but they can buy and sell one-period debt to finance their purchases. We denote this debt by b^r_t and its price by q_{bt}. These households also purchase both market consumption goods $c^r_{\mathrm{m}t}$ and household durable goods $x^r_{\mathrm{h}t}$. Their period budget constraint is

$$c^r_{\mathrm{m}t} + x^r_{\mathrm{h}t} + b^r_t = W_t l^r_{\mathrm{m}t} + q_{bt} b^r_{t+1}. \tag{8}$$

All borrowing by type-r households uses collateralized one-period ahead debt contracts. Type-r households' access to credit markets is imperfect in the sense that lenders are unable to enforce loan repayment. Thus, loan amounts are limited and borrowers need to provide their own wealth as collateral. Here, the collateral is the stock of durable goods or home capital owned by type-r households. In the case of default, the lender is able to seize a fraction of the outside value of the stock and will only lend the amount consistent with the borrower's incentive-compatibility constraint, such that there is no credit default in equilibrium. Denote $q^r_{\mathrm{h}t+1}$ as the date $t+1$ relative price of a unit of installed home capital in terms of market goods. Then the debt contract will specify a repayment of b^r_{t+1} that satisfies the collateral constraint:

$$b^r_{t+1} \leq \theta E_t\left[q^r_{\mathrm{h}t+1}\right] k^r_{\mathrm{h}t+1} \tag{9}$$

where the loan-to-value parameter $\theta > 0$ can be viewed as a credit multiplier: the credit constraint is relaxed as θ increases.

Type-u households also supply labor to the market sector, but can freely access asset markets. As a result, type-u households can buy and sell one-period bonds and market capital. As a result, they earn income from labor and from capital markets, where we denote the rental rate on market capital $k^u_{\mathrm{m}t}$ by R^k_t. These households use their income to purchase market consumption goods $c^u_{\mathrm{m}t}$, household durable goods $x^u_{\mathrm{h}t}$, and market capital goods $x^u_{\mathrm{m}t}$. Their period budget constraint is

$$c^u_{\mathrm{m}t} + x^u_{\mathrm{h}t} + x^u_{\mathrm{m}t} + b^u_t = W_t l^u_{\mathrm{m}t} + R^k_t k^u_{\mathrm{m}t} + q_{bt} b^u_{t+1}. \tag{10}$$

The market sector capital stock evolves as

$$k^u_{\mathrm{m}t+1} = \Psi\left(x^u_{\mathrm{m}t}/k^u_{\mathrm{m}t}\right) k^u_{\mathrm{m}t} + (1-\delta_{\mathrm{m}}) k^u_{\mathrm{m}t} \tag{11}$$

where $0 < \delta_{\mathrm{m}} < 1$ is the depreciation rate of capital stock in the market sector, and $\Psi\left(x^u_{\mathrm{m}t}/k^u_{\mathrm{m}t}\right) = x^u_{\mathrm{m}t}/k^u_{\mathrm{m}t} - (\psi/2)(x^u_{\mathrm{m}t}/k^u_{\mathrm{m}t} - \delta_{\mathrm{m}})^2$, where $\psi \geq 0$ controls the investment adjustment cost.

Market output is produced with capital $K_{\mathrm{m}t}$ and labor $L_{\mathrm{m}t}$:

$$Y_{\mathrm{m}t} = Z_{\mathrm{m}t} K^{\alpha_{\mathrm{m}}}_{\mathrm{m}t} L^{1-\alpha_{\mathrm{m}}}_{\mathrm{m}t} \tag{12}$$

where $K_{\mathrm{m}t} = \omega k^u_{\mathrm{m}t}$, $L_{\mathrm{m}t} = \omega l^u_{\mathrm{m}t} + (1-\omega) l^r_{\mathrm{m}t}$. Market sector TFP is denoted $Z_{\mathrm{m}t}$. It follows

$$\ln(Z_{\mathrm{m}t}/\bar{Z}_{\mathrm{m}}) = \rho_{\mathrm{m}} \ln(Z_{\mathrm{m}t-1}/\bar{Z}_{\mathrm{m}}) + \upsilon_t \tag{13}$$

where υ_t is a mean zero random variable with variance $\sigma^2_{\mathrm{m}} > 0$, $\bar{Z}_{\mathrm{m}} > 0$ is the steady state value of market TFP, and $0 < \rho_{\mathrm{m}} < 1$ denotes the persistence of the deviations of market TFP.

Finally, to close the model, we let

$$B_t = \omega b^u_t + (1-\omega) b^r_t = 0. \tag{14}$$

Aggregate consumption can be decomposed into nondurables and durables: $C_t = C_{\mathrm{n}t} + C_{\mathrm{d}t}$. Nondurable consumption includes consumption of nondurables by both types of households, $C_{\mathrm{n}t} = \omega c^u_{\mathrm{m}t} + (1-\omega) c^r_{\mathrm{m}t}$. Similarly, durable consumption includes purchases of home capital by both types of households, $C_{\mathrm{d}t} = \omega x^u_{\mathrm{h}t} + (1-\omega) x^r_{\mathrm{h}t}$. Aggregate investment is $I_t = \omega x^u_{\mathrm{m}t}$. Finally, aggregate output is $Y_t = Y_{\mathrm{m}t}$.

3.2 Some Properties of the Closed Economy Model

We formally study the effects of financial reforms in the following section. For now, we wish to highlight a few features of the model. In contrast to a standard representative consumer real business cycle model with only market production, our model features two types of production, two types of consumers, and some financial market frictions. These special features interplay to affect the extent of aggregate consumption smoothing.

In particular, consumers engage in the production of both market and non-market goods, and this production is subject to TFP shocks. To a large extent, shocks to market TFP are a source of aggregate risk that affects the market income of both types of consumers and affect the volatility of aggregate consumption. Shocks to home TFP are sources of type-specific risk. The ability to share this specific risk across consumers also affects the volatility of aggregate consumption. The ability to share risk, however, is impeded by financial market frictions. The only asset that is traded across type is a one-period riskless bond and type-r consumers are constrained by their collateral constraint and their relative impatience. Type-r consumers are further constrained by their exclusion from equity markets. These restrictions interplay to make it difficult for type-r consumers to smooth consumption. The extra consumption volatility for type-r consumers is likely to spill over to aggregate consumption volatility, especially if type-r consumers represent a large fraction of the population.

4 Reforms and Consumption Smoothing in the Closed Economy

4.1 Numerical Solution and Calibration

The properties of the model are studied numerically. Standard linear approximation methods are inappropriate because our model has an occasionally binding collateral constraint. We implement the piecewise linear perturbation approach (OccBin) discussed in Guerrieri and Iacoviello (2015). As the authors point out, the advantage of this method is that it can easily handle cases with several state variables (as we have in our model). The method requires that we select a reference regime and an alternate regime. In our implementation, the collateral constraint binds in the reference regime but not in the alternate regime. The general idea of the solution method is to guess and verify whether you are currently in the reference or the alternate regime, knowing that you will eventually return to the state space solution of the reference regime. The transition to the reference regime

is then solved backward assuming perfect foresight to obtain decision rules that apply for the current period. In contrast to standard linear perturbation methods, the resulting state space is time varying. In all cases, we simulate 1000 series of 100 periods and retain only the last 50 periods. The moments we report are computed as the averages of these 1000 simulated series of 50 periods each. Finally, the collateral constraint binds more often at low values of the loan-to-value parameters. For the fully calibrated version of the closed economy, the constraint binds roughly 40 percent of the time when θ is near 0 and 27 percent of the time when $\theta = 1$.

The numerical solution requires values for all parameters. We proceed to calibrate the model as follows. First, we set a number of parameters to values similar to those in Gollin, Parente, and Rogerson (2004). We do so because our closed economy model has many similarities with the model that Gollin, Parente, and Rogerson (2004) use to study the importance of farm and home work in explaining international productivity differences. We then calibrate the remaining parameters to match certain features of the South Korean annual data.

The preference parameters are set as follows. The type-r household is impatient relative to the type-u household: $\beta_r = 0.93$ and $\beta_u = 0.94$. This generates a steady state annual interest rate of roughly 6.4 percent. We also set $\nu = 0.6$ such that the elasticity of labor supply is $1/\nu = 1.67$. We then adopt values of Gollin, Parente, and Rogerson (2004) for the following preference parameters. The elasticity of substitution between market and home produced goods is $\epsilon = 1.67$, while the share parameters are $\mu_r = 0.4$ and $\mu_u = 0.5$ to ensure that type-r households put a higher weight on nonmarket activities. Finally, we set the preference parameter associated to labor to $\varsigma = 0.75$.

The values of the home and market production parameters also follow those of Gollin, Parente, and Rogerson (2004), but the exact values differ slightly. For home production, the only type specific parameter is the level of productivity $\bar{z}^i_{\mathrm{h}}$. We set $\bar{z}^r_{\mathrm{h}} = 1.05$ and $\bar{z}^u_{\mathrm{h}} = 0.94$. These values ensure that type-r households work more at home than type-u households. The capital share in the home sector is $\alpha_{\mathrm{h}} = 0.20$. We set the depreciation rate to $\delta_{\mathrm{h}} = 0.10$. For market production, the capital share is $\alpha_{\mathrm{m}} = 0.33$, the level of productivity to $\bar{Z}_{\mathrm{m}} = 1$, and the depreciation rate to $\delta_{\mathrm{m}} = 0.10$.

The remaining parameters are set to ensure that the model is consistent with South Korean annual data. For the population share, we set ω to 30 percent. This choice is motivated by the fact that, in the Korean data, the top 20 percent of the household distribution saw a reduction in household debt after reform while the bottom 60 percent saw a rise in household debt. We then simply split the middle for the second top quintile who saw no change. The last few parameters are set in a moment matching exercise to ensure that simulated moments are

similar to those of South Korea for the whole sample (the column All for South Korea in Table 1). The method employed is similar to that used in Born and Pfeifer (2014) but adapted to our model and the piecewise linear perturbation solution method. In particular, we calibrate the remaining seven parameters with the following seven moments: the standard deviation of output, the relative standard deviations for all variables (except net exports), the correlation with output for durable consumption, and the autocorrelation for output.

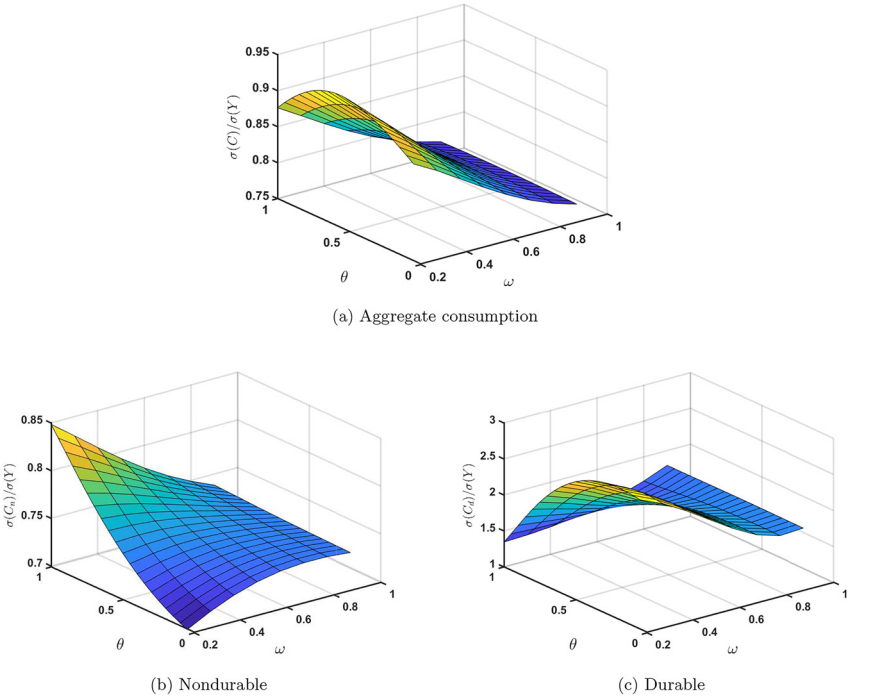
The resulting value of the loan-to-value parameter is $\theta = 0.18$. With this value durable expenditures are about 14 percent of consumption as in the data. The adjustment cost parameters are $\phi = 0.00$ and $\psi = 1.00$. These ensure that the volatility of durable expenditures and aggregate investment match those in the data. Finally, the parameters of the stochastic process that dictates the behavior of home and market TFP are $\sigma_{\mathrm{h}} = 4.00$ percent, $\sigma_{\mathrm{m}} = 1.25$ percent, $\rho_{\mathrm{h}} = 0.40$ and $\rho_{\mathrm{m}} = 0.40$. The simulated moments match the South Korean moments well, but for the relative volatility of investment which is lower.

4.2 Domestic Financial Reforms in the Closed Economy

In our context, relaxing the collateral constraint on type-r households requires raising the loan-to-value parameter θ. To evaluate the effects of such a reform, Figure 1 plots the relative volatility of the cyclical fluctuations of consumption for different values of both ω and θ. To be precise, panel (a) plots the standard deviation of the cyclical fluctuations in the logarithm of consumption relative to the standard deviation of the cyclical fluctuations of the logarithm of output.

As expected, the figure shows that a rise ω that reduces the proportion of type-r in the population unambiguously reduces the relative volatility of consumption. The figure also shows that changes in θ do not have a monotonic effect. At high values of ω, changes in θ have little effect on aggregate consumption volatility simply because the fraction of households affected is too small. For lower values of ω, a relaxation of the collateral constraint, a rise in θ, may lower or raise consumption volatility. When θ is small, a rise in θ raises consumption volatility. Consumption volatility eventually reaches a maximum as θ rises. Once passed this maximum, further increases in θ reduce consumption volatility. Thus, financial reforms of this type may ameliorate or deteriorate consumption smoothing, but only when a sizeable fractions of households (low ω) are heavily constrained (low θ).

As for panel (a), panels (b) and (c) display a decomposition of the relative volatility of consumption into its nondurable and durable components. The effects of relaxing the collateral constraint only occur for low values of ω (high fraction of type-r households). Panel (b) shows that a relaxation of the collateral



(a) Aggregate consumption

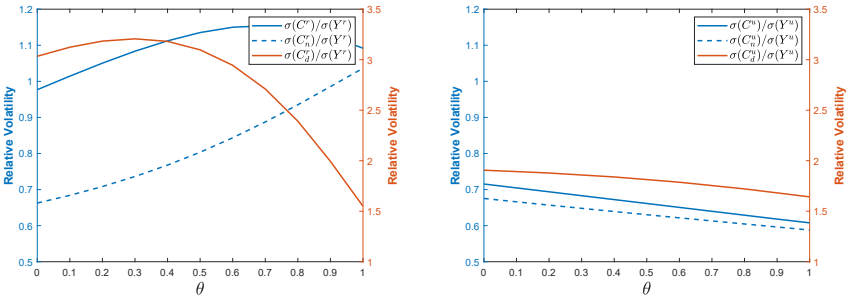
(b) Nondurable

(c) Durable

Figure 1: Financial reforms and consumption volatility.
Note: The figure shows the ratio of the standard deviation of consumption and the standard deviation of output for different values of θ that controls the tightness of the collateral constraint and ω that controls the share of unconstrained type-u households in the population.

constraint raises the volatility of nondurable consumption, no matter the initial level of θ. Panel (c) shows that a relaxation of the collateral constraint produces a slight humpshape response of the relative volatility of durable consumption expenditures but declines rapidly passed it is maximum. The combination of the responses of the relative volatility of nondurable and durable consumption is thus responsible for the hump shape witnessed in the relative volatility of aggregate consumption.

To better understand the effects of the collateral constraint, Figure 2 plots the relative volatility of consumption for the two types of households. For this experiment, we set $\omega = 0.30$, it is calibrated value. Panel (a) shows the relative volatility of consumption for type-r households, while panel (b) does so for type-u households. For type-r households, total consumption is $C_t^r = C_{\mathrm{n}t}^r + C_{\mathrm{d}t}^r$ where nondurable consumption expenditure is $C_{\mathrm{n}t}^r = (1-\omega)c_{\mathrm{m}t}^r$ and durable



(a) Type-r (b) Type-u

Figure 2: Financial reforms and consumption volatility: Type-***r*** vs type-***u***.
Note: The figure shows the ratio of the standard deviation of consumption and the standard deviation of income for different values of θ that controls the tightness of the collateral constraint.

expenditure is $C^r_{\mathrm{d}t} = (1-\omega)x^r_{\mathrm{h}t}$, while income is $Y^r_t = (1-\omega)W_t l^r_{\mathrm{m}t}$. For type-$u$ households, total consumption is $C^u_t = C^u_{\mathrm{n}t} + C^u_{\mathrm{d}t}$ where nondurable consumption expenditure is $C^u_{\mathrm{n}t} = \omega c^u_{\mathrm{m}t}$ and durable expenditure is $C^u_{\mathrm{d}t} = \omega x^u_{\mathrm{h}t}$, while income is $Y^u_t = \omega\left(W_t l^u_{\mathrm{m}t} + R^k_t k^u_{\mathrm{m}t}\right)$.

For the constrained type-r households, the relative volatility of nondurable consumption rises monotonically while that of durable consumption rises, reaches a peak, and then declines. The combination creates the humpshaped responses of the relative volatility of their total consumption. For the unconstrained type-u households, the relative volatility of nondurable, durable, and total consumption decline as θ increases.

Overall, Figures 1 and 2 confirm that the relative volatility of consumption and it is component result from the behavior of the type-r households, as long as they represent a sufficient fraction of the population. More importantly, for type-r consumers, a relaxation of the collateral constraint raises the relative volatility of nondurable consumption and mostly reduces the relative volatility of durable purchases.

4.3 The Importance of Domestic Financial Reforms

Our results suggests that domestic financial reforms that loosen the collateral constraint for type-r households can generate a rise in the relative volatility of consumption. Here, we wish to analyze the factors that affect the importance of the mechanisms that drive these results. We divide this discussion in two parts. First, we discuss the importance of the collateral constraint, and focus on the

importance of the loan-to-value parameter θ. Then, we discuss the importance of home production in affecting the response of the relative consumption volatility to changes in θ.

4.3.1 The Loan-to-Value Parameter θ

In the existing literature, the collateral constraint makes the accumulation of the collateral asset more sensitive to productivity shocks. This heightened sensitivity amplifies the effects of market productivity shocks on market output where the collateral asset is the market stock of capital. The literature does not discuss the amplification effect on consumption. The distinction is important because larger fluctuations of output are likely to generate larger fluctuations of consumption, but not necessarily an increase in the volatility of consumption relative to that of output. Furthermore, Kocherlakota (2000) and Cordoba and Ripoll (2004) argue that the amplification effect is quantitatively unimportant.

The early literature, however, ignores the importance of the loan-to-value parameter θ.[6] In contrast, Mendicino (2012) shows that the quantitative importance of the amplification is a hump shaped function of the loan-to-value parameter. She argues that this pattern occurs because the loan-to-value parameter changes both the steady state productivity of the collateral asset and the fraction of output produced by the constrained households. In that model, the steady state productivity of the collateral asset for the constrained household is a decreasing function of the loan-to-value parameter. All else equal, this makes the amplification effect quantitatively larger at low values of the parameter. The steady state fraction of output produced by constrained households is an increasing function of the loan-to-value parameter. This makes the amplification effect quantitatively more important at large values of the parameter. The combination of these effects gives rise to the hump shape.

Our model differs from the model in Mendicino (2012) but similar considerations are at play. In our model, type-r consumers are constrained, the collateral asset is home capital (durable goods), and the output affected is home production.

The hump-shaped pattern of the relative volatility of durable purchases for type-r consumers depicted in Figure 2 can be explained by steady state changes to the relevant productivity and level of output. The relevant productivity is the marginal product of home capital for type-r consumers. A rise in the loan-to-value parameter lowers the relevant productivity which also reduces the sensitivity of the accumulation of the collateral asset to productivity shocks. First, note that the

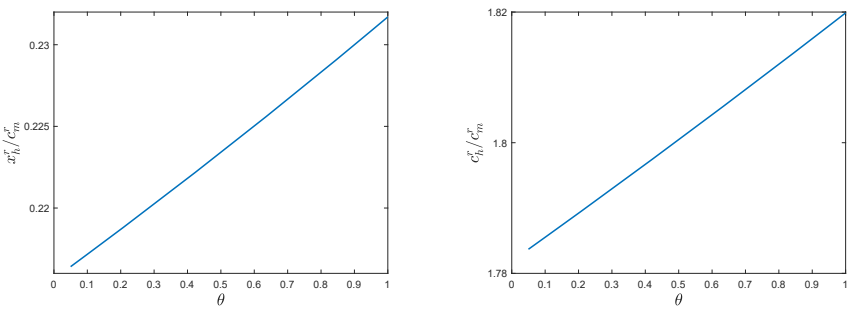
6 Kocherlakota (2000) and Cordoba and Ripoll (2004) consider environments where $\theta = 1$.

marginal product of home capital for type-r consumers, $R_{\mathrm{h}}^{r} = \alpha_{\mathrm{h}} z_{\mathrm{h}}^{r} \left(k_{\mathrm{h}}^{r}/l_{\mathrm{h}}^{r}\right)^{-(1-\alpha_{\mathrm{h}})}$, is strictly decreasing in the loan-to-value parameter. To see this, the deterministic steady state, home sector, capital-labor ratio is

$$\frac{k_{\mathrm{h}}^{r}}{l_{\mathrm{h}}^{r}} = \left(\frac{\alpha_{\mathrm{h}}}{1-\alpha_{\mathrm{h}}}\right)\left[\frac{\beta_{r}\bar{W}}{1-\beta_{r}(1-\delta_{\mathrm{h}})-\theta(\beta_{u}-\beta_{r})}\right],$$

where the market wage is given by $\bar{W} = (1-\alpha_{\mathrm{m}})Z_{\mathrm{m}}\left[\alpha_{\mathrm{m}} Z_{\mathrm{m}}/\bar{R}^{k}\right]^{\alpha_{\mathrm{m}}/(1-\alpha_{\mathrm{m}})}$ for a market marginal product of capital given by $\bar{R}_{k} = \left[1-\beta_{u}(1-\delta_{\mathrm{m}})\right]/\beta_{u}$. The capital-labor ratio is increasing in θ such that the marginal productivity R_{h}^{r} is decreasing in θ.

The relevant output that relies on the collateral asset is type-r home production. A rise in the loan-to-value parameter raises the production of home goods in relation to the consumption of market goods for type-r consumers. To see this, Figure 3 presents the importance of home production relative to consumption of nondurable market goods for type-r consumers. Panel (a) shows the steady state ratio of durable purchases to nondurable market consumption and panel (b) shows the steady state ratio of home goods consumption (or home production) relative to nondurable market goods consumption. The figure shows that a rise in the loan-to-value parameter θ raises both the share of expenditures devoted to the collateral asset used in the production of home goods and the share of consumption of home produced goods relative to nondurable consumption goods.



(a) Durable to nondurable (b) Home to nondurable

Figure 3: Financial reform and steady state home production.
Note: Panel (a) shows the deterministic steady state ratio of type-r durable purchases to nondurable purchases for different values of θ that controls the tightness of the collateral constraint. Panel (b) shows the deterministic steady state ratio of type-r home goods consumption to nondurable consumption for different values of θ that controls the tightness of the collateral constraint.

The trade-off between a reduction in the relevant productivity and a rise in the relative level of production generated by a rise in θ explains the hump shape response of the relative volatility of durable expenditures for constrained type-r households shown in Figure 2. The reduction in the steady state marginal productivity of home capital reduces the impact of the collateral constraint on durable purchases but the rise in the relative importance of home production raises it. For low values of θ, the rise in the relative importance of home production dominates and the relative volatility rises, but for higher values of θ the reduction in the marginal product dominates and the relative volatility decreases.

The rise in the relative volatility of market nondurable consumption shown in Figure 2 follows from the behavior of the relative volatility of home production. In contrast to Mendicino (2012), the hump shape importance of the collateral constraint does not extend to the volatility of home production. Figure 4 shows the relative volatility of both home labor and home production for different values of the loan-to-value parameter θ. The figure shows that a rise in θ raises the volatility of home production. This occurs because, home production in our model relies on both the collateral asset (the stock of durable) and labor while market production in Mendicino (2012) relies only on the collateral asset. As argued earlier, a rise in the loan-to-value parameter θ engineers a reduction in the capital-labor ratio in home production which raises the marginal product of home labor. This, in turn, raises the volatility of home labor and home production.

The rise in the relative volatility of market nondurable consumption follows from a combination of the higher importance of home production relative to market consumption and of the higher volatility of home production for type-r

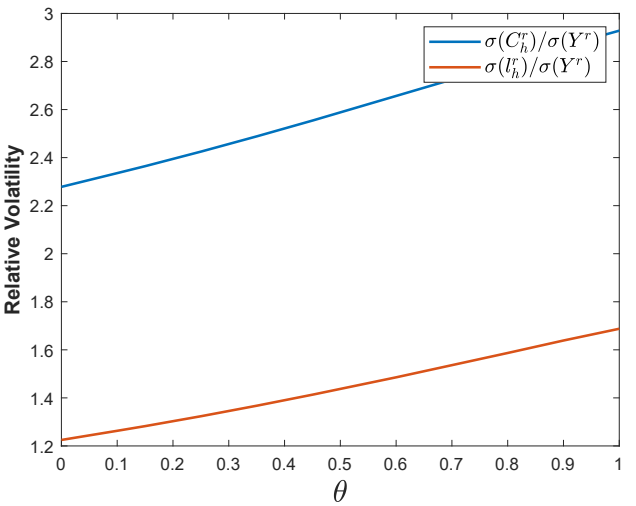


Figure 4: Financial reform and home production volatility.
Note: The figure shows the ratios of the standard deviation labor devoted to home production and of home production to the standard deviation of income for different values of θ that controls the tightness of the collateral constraint.

consumers. In our model, consumption of nondurable goods and home produced goods are nonseparable, such that fluctuations in home production affect nondurable consumption similarly to taste shocks. The result is that a rise in the loan-to-value parameter θ raises the relative importance and volatility of home production which then raises the volatility of market consumption by type-r consumers.

Overall, a rise in the loan-to-value parameter θ lowers the productivity of home capital, the collateral asset, but raises the importance of home production. The combination creates a humpshape in the quantitative importance of the collateral constraint that explains the humpshape in the relative volatility of durable purchases for type-r consumers. In addition, a rise in the loan-to-value parameter θ raises the productivity of home labor, which raises the volatility of home labor and home production. The combination of these effects and the nonseparabilities raises the relative volatility of market nondurable consumption.

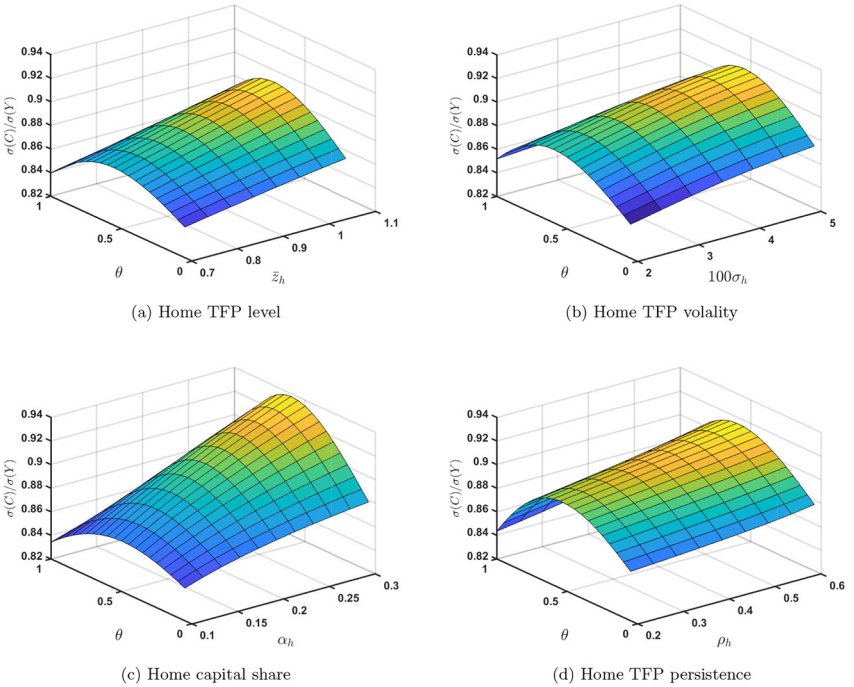
4.3.2 The Importance of Home Production

Our previous discussion suggests that the response of consumption smoothing to changes in the loan-to-value parameter θ is sensitive to the importance of home production.

Figure 5 displays the relative volatility of aggregate consumption for different values of these key parameters. Panel (a) does so for the steady state level of home TFP $\bar{z}_{\mathrm{h}}^{r}$, panel (c) for the capital share α_{h}, panel (b) for the standard deviation of innovations to home TFP σ_{h}, and panel (d) for the persistence of TFP shocks ρ_{h}.

Panel (a) confirms that raising the importance of the level of home production raises the overall volatility of consumption for all θ. Panel (b) reveals that making TFP shocks more volatile also raises the overall volatility of consumption, but hardly affects the shape. These results taken together are consistent with the notion that raising the relative importance of home production, either level or volatility, affects the relative volatility of consumption mostly because home production shocks act like taste shocks.

Panel (c) shows that raising the capital share raises the relative volatility of consumption and makes the humpshape steeper. Panel (d) shows that raising the persistence of home TFP shocks produces a similar pattern. These results confirm that changes to home production that are directly linked to the accumulation of home capital, like the capital share and the persistence of shocks, not only raises the volatility but also magnifies the responses of the accumulation of the collateral assets.



(a) Home TFP level (b) Home TFP volality

(c) Home capital share (d) Home TFP persistence

Figure 5: Financial reform and home production.
Note: The figure shows the ratio of the standard deviation of consumption and the standard deviation of output for different values of θ that controls the tightness of the collateral constraint. Panel (a) does so for different values of the level of home TFP $\bar{z}_h^r$, panel (b) for the standard deviation of innovations to home TFP σ_h, panel (c) for values of the home sector capital share α_h, and panel (d) for the persistence of home TFP hocks ρ_h.

5 Reforms in a Small Open Economy

We extend our analysis to a small open economy because Korea and South Africa are emerging economies that experience fluctuations in their current account. This openness ensures that consumers can borrow internationally but also face disturbances from international shocks. Our extension relies on an international interest rate equation. This modeling device still allows us to study the effects of a relaxation of the collateral constraint in a small open-economy model. Unfortunately, this reduced form modeling device does not permit us to precisely explore the effects of the international components of financial reforms. It captures those effects but cannot distinguish them from other changes to the environment that

would alter the parametrization of the interest rate equation. In what follows, then, we continue to focus our attention to the loan-to-value parameter θ.

5.1 A Small Open Economy

We extend our closed economy model to international borrowing and lending. To do so, we replace the market clearing condition by the interest rate equation

$$R_{bt} = R_t^* + S_t, \tag{15}$$

where R_t^* denotes stochastic international rates while S_t is a country-specific spread.

In this environment, the main source of international risk is stochastic international interest rates. For that, the stochastic process for international rates is

$$\ln(R_t^*/\bar{R}^*) = \rho_R \ln(R_{t-1}^*/\bar{R}^*) + \epsilon_{Rt} \tag{16}$$

where ϵ_{Rt} is a mean zero random variable with variance $\sigma_R^2 > 0$, $\bar{R}^*$ is the steady state value of the world real interest rate, and $-1 < \rho_{\mathrm{R}} < 1$ denotes the persistence of the deviations of the world interest rate from its steady state value.

The country premium spread S_t is described by

$$\begin{aligned} S_t =& \chi \left[\exp(B_{t+1} - B^*) - 1\right] - \pi_{\mathrm{m}} E_t \left[\ln(Z_{\mathrm{m}t+1}/\bar{Z}_{\mathrm{m}})\right] \\ & - \pi_{\mathrm{h}} E_t \left[\omega \ln(z^u_{\mathrm{h}t+1}/\bar{z}^u_{\mathrm{h}}) + (1-\omega)\ln(z^r_{ht+1}/\bar{z}^r_{\mathrm{h}})\right]. \end{aligned} \tag{17}$$

The country spread depends on a country's debt and it is productivity. The first term, controlled by parameter χ, captures the notion that international lenders raise the country premium when a country's debt rises. Schmitt-Grohe and Uribe (2003) shows that such a device is required to ensure that small open-economy models are stationary. Similar devices are used widely to ensure stability in small open-economy models, including those in Aguiar and Gopinath (2007), Alvarez–Parra, Brandao-Marques, and Toledo (2013), Chang and Fernandez (2013), and Garcia-Cicco, Pancrazi, and Uribe (2010).

The next two terms, controlled by π_{m} and π_{h}, capture the notion that international lenders lower the country premium when a country's ability to repay improves. Neumeyer and Perri (2005) show that this device produces countercyclical interest rates that help explain high consumption volatility. The latter occurs because it lowers interest rates when the country is experiencing high productivity. The combination of low interest rate and high productivity both stimulates consumption, such that it raises consumption volatility relative to output. Again, similar devices are used widely in small open-economy models. Alvarez-Parra, Brandao-Marques, and Toledo (2013) and Uribe and Yue (2006)

model the dependence between country spread and output. Uribe and Yue (2006) go further and model the dependence between spread and contemporaneous and lagged values for output, investment, and the trade balance that all affect the ability to repay. Similarly, Chang and Fernandez (2013) and Neumeyer and Perri (2005) model the dependence between country spread and productivity shocks, as these shocks are the main drivers of output, consumption, investment, and the trade balance in their models and thus of the ability to repay. Our approach is in the spirit of Neumeyer and Perri (2005) and Uribe and Yue (2006) in that we model the dependence with market TFP but also add a dependence with home TFP. In our model, both home and market TFP shocks affect the ability to repay because they affect output, consumption, investment, and the trade balance.

Finally, the small emerging economy sees fluctuations in its current account. For future references, our measure of net exports is the ratio of net exports to output $NX_t/Y_t = (Y_t - C_t - I_t)/Y_t$.

Before proceeding, we wish to see how changes in the loan-to-value parameter affect the relative volatility of consumption in the small open-economy. In particular, we wish to see how changes in the loan-to-value parameter interact with the parameters of the interest rate equation. For this, we calibrate the model similarly to our closed economy with some changes. The main parameters appear in Table 2 under parameters that are calibrated externally. Several parameters take the same values that were set for the closed economy version. We calibrate the remaining parameters to again match the South Korean annual data for the whole sample. We set $\bar{R}^* = 1/\beta_u$ so that the deterministic steady state level of interest rate of the small open economy coincides with that of the closed economy, and set B^* to yield a debt to output ratio of roughly 24 percent, similar to Korea's average debt level in recent times. The parameters χ, π_{m}, and π_{h} were set using a grid search to be best match the data prior to the formal moment matching exercise. As before, the last few parameters are set in a moment matching exercise to ensure that simulated moments are similar to those of South Korea for the whole sample (the column All for South Korea in Table 1). We calibrate the remaining nine parameters with the following 10 moments: the standard deviation of output, the relative standard deviations for all variables, the correlation with output for durable consumption and net exports, and the autocorrelations for output and net exports. The resulting value of the loan-to-value parameter is again $\theta = 0.18$. The adjustment cost parameters are $\phi = 3.56$ and $\psi = 1.10$. The parameters of the stochastic process that dictates the behavior of home and market TFP are $\sigma_{\mathrm{h}} = 5.72$ percent, $\sigma_{\mathrm{m}} = 1.10$ percent, $\rho_{\mathrm{h}} = 0.18$ and $\rho_{\mathrm{m}} = 0.22$. Finally, the parameters of the stochastic process that dictates the behavior of world interest rates are $\sigma_{\mathrm{R}} = 0.54$ percent and $\rho_{\mathrm{R}} = 0.97$. The simulated moments

Table 2: Calibration for South Korea and South Africa.

Calibrated Externally										
Common	β_r	β_u	ς	ν	ϵ	μ_r	μ_u			
	0.93	0.94	0.75	0.6	1.67	0.40	0.50			
	$\bar{z}^r_{\mathrm{h}}$	$\bar{z}^u_{\mathrm{h}}$	α_{h}	δ_{h}	$\bar{Z}_{\mathrm{m}}$	α_{m}	δ_{m}			
	1.05	0.94	0.20	0.10	1.00	0.33	0.10			
	B^*	π	π_{m}	π_{h}						
	0.10	0.50	3.00	1.00						
South Korea	$\omega = 0.30$									
South Africa	$\omega = 0.20$									
Calibrated by Matching Moments										
		θ	ϕ	ψ	$100\sigma_{\mathrm{m}}$	ρ_{m}	$100\sigma_{\mathrm{h}}$	ρ_{h}	$100\sigma_{\mathrm{R}}$	ρ_{R}
South Korea	Pre	0.00	2.00	0.70	1.52	0.16	0.02	0.35	0.21	0.92
	Post	0.75	6.23	2.13	0.35	0.23	3.77	0.19	0.66	0.71
		θ	ϕ	ψ	$100\sigma_{\mathrm{m}}$	ρ_{m}	$100\sigma_{\mathrm{h}}$	ρ_{h}	$100\sigma_{\mathrm{R}}$	ρ_{R}
South Africa	Pre	0.45	3.30	1.34	0.67	0.32	4.48	0.27	0.75	0.64
	Post	0.75	4.21	2.75	0.24	0.79	5.01	0.33	0.02	0.41

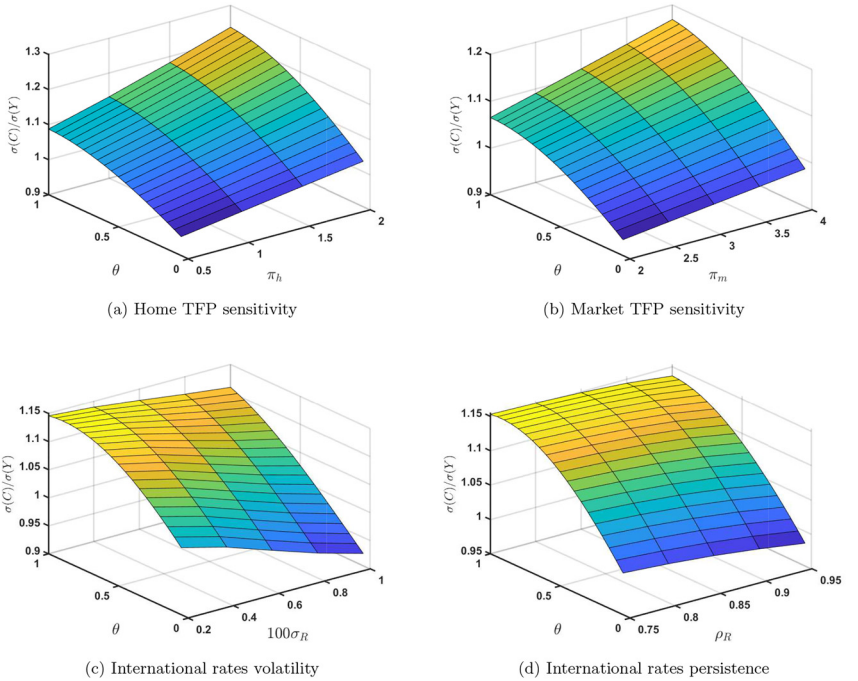
match the South Korean moments reasonably well, but net exports are not as countercyclical as in the data.

The pattern of the relative volatility of consumption observed in the closed economy carry over to the small open-economy version of the model. In addition, changes to parameter χ do not alter this relation, at least not for values in the range that we consider. Figure 6 displays the relative volatility of aggregate consumption for different values of the other parameters. Panel (a) does so for the sensitivity of the country spread to home TFP π_{h}, panel (b) for the sensitivity of the country spread to market TFP π_{m}, panel (c) for the standard deviation of innovations to world interest rates σ_{R}, and panel (d) for the persistence of world interest rate shocks ρ_{R}.

As expected, the figure shows that raising the sensitivities π_{h} and π_{m} raises the relative volatility of consumption. It also magnifies the effects of a change in the loan-to-value parameter θ. Changes in either the standard deviation σ_{R} or the persistence ρ_{R} interact little with changes in the loan-to-value parameter θ.

5.2 Reforms in South Korea and South Africa

We now evaluate whether the model can replicate the pro and post-reform business cycle moments for both countries. Admittedly, several years elapse between the pre and post-reform periods. During that time, there might be several changes



(a) Home TFP sensitivity

(b) Market TFP sensitivity

(c) International rates volatility

(d) International rates persistence

Figure 6: Financial reform and interest rates.
Note: The figure shows the ratio of the standard deviation of consumption and the standard deviation of output for different values of θ that controls the tightness of the collateral constraint. Panel (a) does so for different values of the sensitivity of the country premium to home TFP π_h, panel (b) for sensitivity of the country premium to market TFP π_m, panel (c) for the standard deviation of innovations to international interest rates σ_R, and panel (d) for the persistence of international interest rate shocks ρ_R.

that affect a country's economy and change the ability of consumers to smooth consumption. Among those changes, we wish to evaluate the role played by easing the collateral constraint. In light of this, we proceed as follows. We calibrate the model to best match both periods in both countries. This requires several parameter changes, including changes to the loan-to-value parameter. We then gauge the importance of the changes in the loan-to-value parameter on consumption smoothing. As before, a number of parameters are calibrated externally, while another group is calibrated in a moment matching exercise. The exact calibration for both countries appear in Table 2.

The parameters calibrated externally that are common to both countries take the values discussed previously. The only parameter calibrated externally that

differs across the two country is the population share. As discussed previously, we set ω to 30 percent for South Korea. We set ω to 20 percent for South Africa. This choice is motivated by the fact that the 1995 Census reported that Whites formed roughly 13 percent of the population, and enjoyed very little unemployment and high levels of education. Interestingly, Indians who formed 3 percent of the population also enjoyed little unemployment and high levels of education. In contrasts, Coloureds and Africans displayed high unemployment and low education. We then use a value slightly hire than the sum of those numbers, which likely overstates the size of the type-u population.

The remaining parameters are again set in a moment matching exercise but here it is country and period specific. For this, we use the observed moments that appear in the different columns of Table 2 (see also Tables 3 and 4). As before, we calibrate the remaining nine parameters with the standard deviation of output, the relative standard deviations for all variables, the correlations with output for durable consumption and net exports, as well as both autocorrelations.

All of these parameters affect all moments. At the same time, a number of parameters are identified more directly from their influence on specific moments. For example, the adjustment costs parameters ϕ and ψ most directly control the relative volatility of durable expenditures and aggregate investment. The parameters of the stochastic process for market TFP, σ_{m} and ρ_{m}, most directly control the volatility of output and it is autocorrelation, while the parameters of the stochastic process for home TFP, σ_{h} and ρ_{h}, most directly control the relative volatility and procyclical behavior of home production and thus nondurable consumption. The parameters of the world interest rate shocks, σ_{R} and ρ_{R}, affect the relative volatility of both aggregate investment and net exports and the autocorrelation of output and net exports. Finally, the loan-to-value parameter θ affects the relative volatility of consumption.

A comparison of the pre-reform and post-reform calibrations highlights a number of interesting features. Both countries see substantial increase in the post-reform value of the loan-to-value parameter θ, suggesting that the domestic component of the reforms mattered. Recall that a rise in θ raises the volatility of nondurable consumption and produces an initial rise followed by a decline in the volatility of durable consumption. The pre-reform value of θ is near 0 for South Korea because the relative volatility of nondurable consumption is only 0.50, but it is 0.45 for South Africa because the relative volatility of nondurable consumption is 1.02.

Both countries see a reduction in the standard deviation of market TFP, σ_{m}, but the reduction is much more pronounced for South Korea. This reduction is necessary to match the decline in the volatility of output from 3.35 to 1.08 percent. South Korea also sees a substantial increase in the standard deviation of home

Table 3: Simulated reforms in South Korea.

	South Korea		Model			
			Pre-reform		Post-reform	
	Pre	Post	Pre	θ^+	Post	θ^-
Volatility						
Output	3.35	1.08	3.34	3.13	1.07	1.26
Volatility relative to output						
Consumption	0.57	1.34	0.91	1.10	1.34	1.05
Nondurable	0.50	1.26	0.80	0.92	1.12	0.81
Durable	1.81	2.89	1.78	2.43	2.90	2.90
Investment	3.34	3.93	3.31	3.41	3.89	3.84
Net export ratio	0.52	1.56	0.76	1.00	1.57	1.13
Correlation with output						
Consumption	0.85	0.56	0.91	0.83	0.56	0.79
Nondurable	0.73	0.53	0.91	0.88	0.60	0.80
Durable	0.75	0.45	0.79	0.63	0.41	0.66
Investment	0.76	0.65	0.64	0.60	0.25	0.38
Net export ratio	−0.17	0.04	−0.12	−0.14	0.13	0.03
Autocorrelation						
Output	0.58	0.16	0.61	0.63	0.42	0.53
Net export ratio	0.74	0.74	0.51	0.43	0.33	0.38

Note: The numbers are the averages of 1000 simulated series of 50 periods each, simulated using the piecewise linear perturbation method of Guerrieri and Iacoviello (2015). The observed moments are from Table 1. For the model moments, the simulation employs the parametrization displayed in Table 2. For the Pre-Reform period, the numbers that appear under Pre use the full pre-reform calibration, while the numbers that appear under θ^+ substitute the post-reform value of θ. For the Post-Reform period, the numbers that appear under Post use the full post-reform calibration, while the numbers that appear under θ^- substitute the pre-reform value of θ.

TFP, σ_{h}, and of international interest rates, σ_{R}, not seen in South Africa. The large increase in σ_{h} from 0.02 percent to 3.77 percent is necessary to match the large increase in the relative volatility of durable consumption from 1.81 to 2.89 and the decline in the correlation between durable expenditures and output from 0.75 to 0.45. The changes in these moments are much smaller for South Africa.

To get a more complete view of the increase in σ_{R}, we compute a scaled unconditional volatility of international interest rates as $(100\sigma_R)^2/(1-\rho_R^2)$. The scaled unconditional volatility rises from 0.29 with the pre-reform calibration to 0.88 with the post-reform calibration for South Korea. In contrast, the scaled unconditional volatility goes from 0.95 to 0.88 for South Africa. The large increase for South Korea is required to match the large increase in the relative volatility of

Table 4: Simulated reforms in South Africa.

	South Korea		Model			
			Pre-reform		Post-reform	
	Pre	Post	Pre	θ^+	Post	θ^-
Volatility						
Output	1.95	1.59	1.94	1.81	1.57	1.72
Volatility relative to output						
Consumption	1.32	1.44	1.40	1.57	1.60	1.47
Nondurable	1.02	1.16	0.97	1.15	1.21	1.03
Durable	4.21	4.07	4.23	4.08	4.07	4.22
Investment	5.32	3.33	5.30	5.51	3.30	3.17
Net export ratio	1.89	1.20	1.71	1.97	1.33	1.15
Correlation with output						
Consumption	0.67	0.93	0.73	0.63	0.77	0.83
Nondurable	0.55	0.92	0.83	0.73	0.80	0.87
Durable	0.67	0.81	0.53	0.41	0.64	0.70
Investment	0.79	0.84	0.37	0.32	0.60	0.63
Net export ratio	−0.46	−0.46	−0.12	−0.07	−0.28	−0.32
Autocorrelation						
Output	0.47	0.62	0.68	0.65	0.72	0.75
Net export ratio	0.74	0.78	0.23	0.23	0.22	0.23

Note: The numbers are the averages of 1000 simulated series of 50 periods each, simulated using the piecewise linear perturbation method of Guerrieri and Iacoviello (2015). The observed moments are from Table 1. For the model moments, the simulation employs the parametrization displayed in Table 2. For the Pre-Reform period, the numbers that appear under Pre use the full pre-reform calibration, while the numbers that appear under θ^+ substitute the post-reform value of θ. For the Post-Reform period, the numbers that appear under Post use the full post-reform calibration, while the numbers that appear under θ^- substitute the pre-reform value of θ.

their net exports from 0.52 to 1.56. It also help make net exports slightly procyclical. The modest decline for South Africa is needed to match the reduction in the relative volatility of net exports.

5.3 Business Cycle Moments

Tables 3 and 4 present observed and simulated business cycle moments for South Korea and South Africa. The first two columns are observed moments from Table 1. The following two columns display simulated business cycle moments for the pre-reform period, while the last two columns do so for the post-reform

period. More specifically, columns 3 and 5 show the simulated moments generated by the model using the full pre-reform and post-reform calibrations. Column 4 and 5 display simulated moments generated with alternate parametrization of the loan-to-value parameter θ.

Overall, the model provides a reasonable description of the business cycle for these two countries, but the model generally underpredicts the persistence of net exports. For South Korea, the calibrated model overpredicts the relative volatility of nondurable consumption and by extension aggregate consumption for the pre-reform period. The match is excellent for the relative volatility of durable consumption because it is controlled by different home TFP shocks and a by the adjustment cost parameter. We note that the model can deliver a lower relative volatility for consumption in the closed economy version, but the added open-economy features that ensures countercyclical interest rates raise the volatility of consumption. The calibrated model also fails to match the very low persistence of output in the post-reform period. The main mechanism to reduce this persistence requires reducing the persistence of both market and home TFP shocks, but this also makes net exports less countercyclical and much less persistent.

For South Africa, the calibrated model adequately predicts the relative volatility of consumption and it is components, but underpredicts the extent to which net exports are countercyclical in the pre-reform period. This occurs because the calibration requires more important international interest rate shocks to help match the higher net exports volatility. More important international rate shocks make net exports more volatile, but also make net exports much less countercyclical and less persistent.

We wish to gauge the share of the increase in the relative volatility of consumption that is attributable to the rise the loan-to-value parameter θ. However, attributing changes in the relative volatility of consumption to only one parameter is difficult as all parameters interact in producing business cycle moments. With this caveat in mind, we perform two experiments. The first computes the business cycle moments using pre-reform calibration with the post-reform calibration of the loan-to-value parameter θ. This experiment should inform on the effects of domestic reform if the world had remained in it is pre-reform state. We also compute the business cycle moments using the post-reform calibration with the pre-reform calibration of the loan-to-value parameter θ. This should inform on the effects of domestic reform if the world had transformed in it is post-reform state. The results of those experiments appear in columns 4 and 6 in Tables 3 and 4.

For South Korea, the fully calibrated model underpredicts the observed increase in the relative volatility of consumption and nondurable consumption between the pre-reform and post-reform periods, but correctly predicts the rise in the relative volatility for durable consumption. The underprediction occurs

because the simulated relative volatilities overstate the observed ones in the pre-reform period. For example, the observed relative volatility rises from 0.57 to 1.34 for aggregate consumption and from 0.50 to 1.26 for nondurable consumption, while the fully calibrated version predicts that the relative volatility rises from 0.91 to 1.34 for aggregate consumption and from 0.80 to 1.12 for nondurable consumption.

For the first experiment, the rise in θ from 0 to 0.75 raises the relative volatility from 0.91 to 1.10 for aggregate consumption and from 0.80 to 0.92 for nondurable consumption. So, of the overall simulated changes, the increase in θ would account for about 44 percent of the rise for aggregate consumption and 38 percent of the rise for nondurable consumption. For the second experiment, the reduction in θ lowers the relative volatility from 1.34 to 1.05 for aggregate consumption and from 1.12 to 0.81 for nondurable consumption. Thus, lowering θ would account for about 67 percent of the change for aggregate consumption and almost all of the change for nondurable consumption. For durable consumption, the change in θ has a large effect in the first experiment but none in the second experiment.

For South Africa, the fully calibrated model overpredicts the true rise in the relative volatility of consumption and nondurable consumption between the pre-reform and post-reform periods, but again correctly predicts the reduction in the relative volatility for nondurable consumption. The observed relative volatility rises from 1.32 to 1.44 for aggregate consumption and from 1.02 to 1.16 for nondurable consumption, while the fully calibrated version predicts that the relative volatility rises from 1.40 to 1.60 for aggregate consumption and from 0.97 to 1.21 for nondurable consumption.

For the first experiment, the rise in θ from 0.45 to 0.75 raises the relative volatility from 1.40 to 1.57 for aggregate consumption and from 0.97 to 1.15 for nondurable consumption. So, of the overall simulated changes, the increase in θ would account for about 85 percent of the rise for aggregate consumption and 75 percent of the rise for nondurable consumption. For the second experiment, the reduction in θ lowers the relative volatility from 1.60 to 1.47 for aggregate consumption and from 1.21 to 1.03 for nondurable consumption. Thus, lowering θ would account for about 65 percent of the change for aggregate consumption and 75 percent of the change for nondurable consumption. For durable consumption, the change in θ has a large effects in both experiments.

Taken together, these simulation results suggest a few takeaways. First, changes in the loan-to-value parameter match better the changes in consumption smoothing in South Africa because the changes in the relative volatility of consumption and it is components are modest. The changes align better with the pattern described in Figures 1 and 2 where a rise in the loan-to-value parameter,

in the upper range, raises the relative volatility of nondurable consumption and lowers the relative volatility of durable consumption. Second, changes in the loan-to-value parameter have a smaller effect in South Korea because the changes in the relevant relative volatilities are much more dramatic. In addition, the full calibration requires that home TFP shocks and international interest rate shocks become much more important in the post-reform period and this explains a large fraction of the worsening of consumption smoothing. The different calibration is required to match changes in other business cycle moments. For example, the importance of market TFP shocks must decline because output becomes much less volatile. Home TFP shocks must become more important because the relative volatility of durable rises sharply while durable consumption becomes less procyclical. Finally, international rate shocks must also become more important because net exports become much more volatile and slightly procyclical. Notwithstanding these changes, the increase in the loan-to-value parameter conservatively explains around 40 percent of the worsening of consumption smoothing.

6 Conclusion

Our reading of the empirical literature on consumption in developing and emerging economies reveals that researchers believe that the interplay between household credit and durable purchases are important determinants of consumption behavior in developing and emerging economies. Furthermore, our reading of reform efforts in South Korea and South Africa confirms that the reforms enacted an important relaxation of the collateral constraint faced by lower income households. For these reasons, we construct a closed economy model that emphasizes the interplay between household credit and durable purchases at the household level, and where a domestic financial reform relaxes the collateral constraint on lower income households.

Our closed economy model predicts that a relaxation of the collateral constraint on lower income households may deteriorate consumption smoothing (raise the volatility of consumption relative to that of output) when a large share of the population is credit constrained and when home production is particularly important.

We then embed the main framework into a small open economy model of an emerging economy to gauge the importance of the domestic component of financial reforms. Our analysis suggests that the relaxation of the collateral constraint could account for at least 40 percent of the observed changes in the relative volatility of consumption in South Korea and South Africa after their financial reforms.

7 Data Appendix

All our annual data is retrieved from OECD.Stat. We use Main Aggregates for Gross Domestic Product (expenditure approach) and the detailed tables for consumption, investment and net exports. All are in constant prices (national base year) with a base year of 2015 for Korea and 2010 for South Africa. Our measure of durable consumption includes both durable and semi-durable goods, while our measure of non-durable consumption includes both non-durable goods and services. The population data refers to total population (national concept). The sample cover 1970 to 2019 for South Korea and 1960 to 2019 for South Africa.

The different moments are computed from the detrended logarithm of real per capita variables using the HP filter with a smoothing parameter of 100, except for net exports. To be consistent, we construct a linearly detrended net exports to output ratio. In all cases, the different periods and countries are treated as separate samples.

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