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Finance and Growth: From the Business Cycle to the Long Run

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Highlights

- We propose a new methodology to estimate the long-run elasticity between growth and finance.
- The contemporaneous relationship between financial booms and economic growth is positive for a complete growth cycle, even if high financial growth makes recessions more severe.
- Financial booms have however a persistent effect detrimental to subsequent cycles, which is referred as a hysteresis phenomenon.
- We define the threshold of financial development above which the persistent effect dominates the contemporaneous effect.
- The total effect of finance on growth is negative as this threshold is exceeded in our panel of economies.

Abstract

This paper proposes a new methodology to assess the long-run relationship between economic and financial growth. By linking long-run growth to the properties of business cycles, this methodology offers a better understanding of the channels through which finance can impact long-term growth. We first define the direct elasticity between financial and economic growth to measure the contemporaneous effect of financial growth. If financial booms make recessions more severe, losses of growth during recessions are low when compared with growth supplements during expansions. Beyond this contemporaneous effect of financial booms, we identify a persistent effect of financial growth detrimental to subsequent cycles, which is referred as a hysteresis phenomenon. Then, financial and economic growth rates are positively correlated only up to a certain threshold of financial activity. In our panel of economies, the average level of financial activity is well above this threshold, implying that the total elasticity between finance and growth is negative in the long run.

Keywords

Growth, Business Cycles, Hysteresis, Financial Cycles, Growth Cycles.

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E32, E44.

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RESEARCH AND EXPERTISE
ON THE WORLD ECONOMY

Finance and Growth: From the Business Cycle to the Long Run

Thomas Grjebine,* and Fabien Tripier†

"How long has it been since the American economy enjoyed reasonable growth, from a reasonable unemployment rate, in a financially sustainable way? The answer is that is has been really quite a long time, certainly more than half a generation". Summers (2015)

"We may be an economy that needs bubbles just to achieve something near full employment". Krugman (2013)

1. Introduction

The "Secular Stagnation" debate launched by Summers (2013) and Krugman (2013) has recently revived the attention on the difficulties to conciliate economic growth with financial stability. They raise in particular the question of what would have been growth during the last thirty years in developed economies without financial and housing bubbles. This debate highlights the complexity of the interactions between economic growth and finance, which has been alternatively pointed out as a key driver of economic growth and a major source of amplification of economic crisis. This paper proposes a new empirical methodology which provides a unified framework to estimate and compare these different effects throughout and across business cycles.

This novel framework uncovers three new important patterns. First, even if high financial growth[1] makes recessions more severe, the elasticity between finance and growth for a complete business cycle is found on average positive. Second, this positive elasticity should be adjusted downward by the excessive development of finance inherited from previous cycles, which is referred as a hysteresis phenomenon. Third, there is a threshold of financial activity above which the elasticity between finance and growth becomes negative in the long run, i.e. over several cycles, because of the hysteresis effects of financial growth.

Our methodology allows to synthesize in a unified framework two strands of the literature on growth and finance. A large empirical literature on long-run growth has been developed in the tradition of King and Levine (1993) after the precursory contributions of Goldsmith (1969) and McKinnon (1973). The starting point of this literature is to regress long-run growth for a panel of country on a set of variables among which one of them measures the development of the financial sector and the

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[1]Financial growth refers to the growth rate of financial series (as house prices) and indicators of financial development (as credit to GDP ratio).

other are control variables. This literature concluded on the existence of a positive and significant relationship between average growth and various measures of financial activity – see among others Levine (1997), Benhabib and Spiegel (2000) and Beck et al. (2007) – even if recent studies have challenged the robustness of this conclusion as Cecchetti and Kharroubi (2012), Rousseau and Wachtel (2011, 2015) or Arcand et al. (2015). To take into account the time-varying behavior of the financial sector, these studies estimate dynamic panels using window of several years (generally five years) to eliminate business cycle fluctuations. Another recent literature focuses precisely on business cycle fluctuations to identify the links between financial activity and economic crisis. Actually, they do not consider all business cycle fluctuations, but they focus instead on the recessions' characteristics, that is the probability of occurrence, the severity, and the duration. Drehmann et al. (2012) show that financial cycle peaks are very closely associated with financial crises and business cycle recessions are much deeper when they coincide with the contraction phase of the financial cycle; Claessens et al. (2012) that the duration and amplitude of recessions are higher when they occur with financial disruptions; Jordà et al. (2013) that the severity of recessions is amplified by the intensity of financial development[2]; and Schularick and Taylor (2012) that the credit ratio is a good predictor of financial crisis[3]. In this literature, less attention is given to economic expansions, which however determine the long-run growth when cumulated over the cycles of an economy.

To sum up, the literature on growth does not consider the specificity of business cycle phases while the literature on recessions does not take into account the economic growth process associated with the expansion phases. In this article, we fill the gap between these two strands of the literature by providing a unified empirical framework. By doing so, we complement recent attempts in the literature to balance the various interactions between finance and growth by Ranciere et al. (2006), Loayza and Ranciere (2006), Bonfiglioli (2008), and Rancière and Tornell (2016).[4] The key point of our approach is that we do not split series into trend and cyclical components by removing a trend from original series to get the cyclical fluctuations. Instead, we study the classical business cycle which is defined by the analysis of turning points (known as peaks and troughs) between expansion and recession phases – see Stock and Watson (1999).[5] The interest of this set-up is to link the long-run economic growth to the properties of business cycles. Indeed, the long-run growth of an

[2]See also Mian et al. (2015) who show that an increase in the household debt to GDP ratio over a three year period predicts lower GDP growth over the next three years. They depart from the above literature as their results are not conditional on having a recession.

[3]See also Borio et al. (2013) who develop measures of potential output and output gaps in which financial factors play a central role.

[4]Ranciere et al. (2006) develop a setup to decompose the effects of financial liberalization on economic growth and on the incidence of crises. To do so, they introduce crisis events into standard growth regressions augmented with financial variables. Loayza and Ranciere (2006) propose an estimation of the short- and long-run impacts of financial intermediation using the Pooled Mean Group estimator developed by Pesaran et al. (1999). They find a positive long-run relationship between financial intermediation and output growth that co-exists with a mostly negative short-run relationship. In a similar manner, Bonfiglioli (2008) studies the effects of financial globalization on investment and productivity growth by controlling for indirect effects on banking and currency crisis. Rancière and Tornell (2016) develop a two-sector model consistent with these empirical facts in which financial liberalization may increase growth, but leads to more crises and costly bailouts.

[5]Gadea Rivas and Perez-Quiros (2015) study the relations between credit and growth both during expansion and

Table 1 – Results: Summary table

	Growth Channel			Duration Channel			Total
Effects of	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Excess Finance	Expansion	Recession	Cycle	Expansion	Recession	Cycle	Total
(a) Direct effect	$+$	$-$	$+$	$+$	0^*	$+$	$+$
(b) Persistent effect	$-$	$-$	$-$	0^*	0^*	0^*	$-$
(c) Total effect	$+$	$-$	$-$	$+$	0^*	$+$	$-$

This table summarizes our results for the six measures of excess finance. * indicates that we get a different result for at least one of the six variables.

economy is equal to the average growth observed for all business cycles of this economy. We show that the elasticity between growth and finance can be expressed as the sum of elasticities associated with the business cycle properties. By linking long-run growth to the properties of business cycles, this methodology offers a better understanding of the channels through which finance can impact long-term growth.

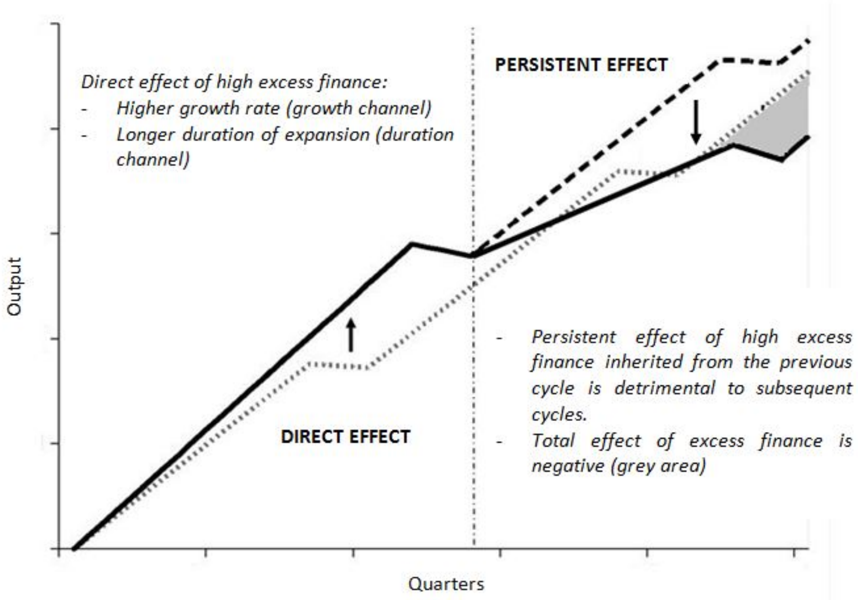
The channels through which finance can impact long-term growth are investigated at two levels, which are summarized in Table 1 and Figure 1 – the solid line corresponds to the economic activity when financial growth is high, while the dotted line is the level of output when the financial growth is equal to its mean-value in the sample. The first level of analysis corresponds to the contemporaneous effect of financial growth on a complete business cycle, composed of one expansion and one recession, which is interpreted as the direct effect – the line (a) of the Table 1 and the first half of the Figure 1. Finance-growth interactions are the result of two channels : (i) the growth channel, associated with the difference in the growth rates between the expansion and recession phases, and (ii) the duration channel, associated with the difference in the durations of the expansion and recession phases.

The second level of analysis corresponds to the interdependencies between business cycles, through the persistent effects of financial growth on the initial value of financial series for subsequent cycles – the line (b) of the Table 1 and the second half of the Figure 1. We refer to this phenomenon as hysteresis because the consequences of a high financial growth episode can persist even if high financial growth has stopped – see Blanchard et al. (2015) and Gali (2016) for recent contributions on the importance of the concept of hysteresis to understand the full consequences of recessions. This can also be related with the concept of "Debt Supercycle" developed by Rogoff (2015) according to which the inheritance of excessive development of finance in the past can lead to long-lasting low economic growth. The total effect of financial growth is computed as the sum of direct and persistent effects – the line (c) of the Table 1.

Our methodology is applied to a panel of 26 countries over the period 1970-2015. The application of this methodology requires an empirical measure for finance. The recent empirical literature uses measures of financial activities around the peaks of economic activity to assess their interactions

recession phases, as we do, but with a different objective. The authors' objective is to assess the ability of credit-based indicators to forecast efficiently the recessions. They show the poor performances of credit-based indicators in out of sample prediction of crisis because of the procyclical behavior of credit, which increases during expansion.

Figure 1 – Direct Effect, Persistent Effect and Total Effect of Excess Finance



Notes: Output paths for business cycles with high excess finance (*solid line*) compared to business cycles without excess finance (*dotted line*). The *dash-line* represents the pattern for a business cycle with high excess finance during the previous cycle but without persistent effect in the current cycle. The *grey area* represents the total effect of excess finance (Direct effect+ Persistent effect).

with economic growth during the recessions, see Drehmann et al. (2012), Claessens et al. (2012), Schularick and Taylor (2012), and Jordà et al. (2013). Because we want to balance these interactions with what happens during expansions, we follow these authors and consider measures of financial activities at the peaks of business cycles. More precisely, we consider the growth rate of financial series during the expansion phase for each business cycle taken in deviation with the mean of growth observed for all business cycles, as in Jordà et al. (2013), and label this measure "excess finance". To take into account the persistent effects of financial growth of one business cycle on the subsequent cycles, we also include in our study the initial value of the financial series at the beginning of each business cycle. We take house prices as the benchmark for the financial series. Business cycles are defined by the identification of turning points in the real GDP per capita for each country.

Our first result is that the contemporaneous relationship between financial growth and economic growth is positive for a complete business cycle. This direct effect is depicted on the first half of the Figure 1: we find both a longer duration of the expansion and a higher level of growth for the cycle - even if the recession is more severe[6]. Our framework allows a better understanding of the channels through which finance can impact growth. In particular, the positive direct relationship

[6]This result is close to that of Ranciere et al. (2006) and Bonfiglioli (2008) who conclude that the direct positive effect of financial development on growth outweighs the indirect and negative effect associated with crisis occurrence.

between finance and growth – column (7) on line (a) of the Table 1 – does not only come from higher growth rates but also from longer duration of expansions – columns (3) and (6) on line (a) of the Table 1. For example, for house prices, the total elasticity is equal to 3.4%[7]. This elasticity is the sum of the elasticities linked to the growth channel (3.1%) and the duration channel (0.3%). Looking at the growth channel, the elasticity is positive during the expansion (5%) and turns negative during the recession phase (-1.9%).[8]

However, this result does not take into account the persistent effects of excess finance on subsequent cycles through the initial value of financial series. Actually, our second result is that the relationship between the initial value of the financial series at the beginning of a business cycle and the economic growth during this cycle is negative – column (7) on line (b) of the Table 1. This persistent effect is depicted on the second half of Figure 1: the solid line crosses back the dotted line quickly after the beginning of the subsequent cycle and remains below. The bold dotted line plots the level of output with high financial growth when hysteresis effects are not accounted for. It gives a graphical intuition for our novel finding that finance is detrimental over the long run: hysteresis effects of high financial growth reduce the slope of the subsequent cycles.

To sum up, financial growth is positively related with economic growth - through the direct effect – and negatively – through the persistent effect. We compute the threshold of financial activity above which the persistent effect outweighs the direct effect, making financial growth detrimental to economic growth. In our sample of economies, the average level of financial activity is well above this threshold, implying a negative elasticity between finance and growth[9] – hence the negative sign on line (c) for the Total effect in Table 1. For example, for house prices, this elasticity is equal to -2.7%, which is the sum of the 3.4% for the direct elasticity and the -6.1% associated with the persistent effects.

For robustness, we show that our regression results are roughly the same for five other measures of excess finance – the Price-to-Rent ratio, Real Credit, Credit to GDP, Real Households Credit, Households Credit to GDP – and when properties of the financial cycle are explicitly taken into account – as the occurrence of bank crisis. We show also that our results are robust to controlling for endogeneity as recently suggested by Arcand et al. (2015).[10] We finally test the hypothesis that the hysteresis effect could come from the link between finance and productivity as financial booms could affect negatively productivity with long-term consequences on economic growth.

The rest of the paper proceeds as follows. In Section 2, we describe the empirical methodology. In

[7]This number should be interpreted as follows: a 1% excess finance is associated in the data with a variation of 0.03 points of percentage of GDP quarterly growth.

[8]The sum of these two elasticities is the value of the growth channel (3.1%).

[9]In average for our six measures of excess finance, this threshold corresponds to a third of the level of the financial series observed in our sample in 2014-2015.

[10]Following Arcand et al. (2015), we control for endogeneity of our regression models using the estimators developed by Rigobon (2003) and Lewbel (2012) that allow to identify causal relationships through heteroskedasticity. In the presence of heteroskedasticity in the regression's residual, this methodology allows identifying causal relationships even in the absence of external instruments.

Section 3, we present the data. In Section 4, we show the results and we propose simulations of GDP patterns depending on variations in excess finance. In Section 5, we propose robustness checks by using alternative measures of finance, controlling for endogeneity and for the financial cycle.

2. Methodology

This section describes the empirical methodology (calculus details are provided in Appendix C).

2.1. Business Cycles and Excess Finance

We consider a panel of n countries indexed by $i = 1, ..., n$ where T_i is the number of observations of the series for the country i. To implement our methodology, the series should be defined in the dimension of economic cycles and not only in the time domain. For each country i, we observe $c = 1, ..., C_i$ cycles. For each cycle c, $s = 1, ..., \tau_c$ stands for the quarter of the cycle and τ_c for the duration of the cycle. In the cycle dimension, $Y_{i,c,s}$ denotes the real GDP per capita observed during the quarter s of the cycle c in country i, which quarterly growth rate is denoted $g_{i,c,s} \equiv \log\left(Y_{i,c,s}/Y_{i,c,s-4}\right)/4$. The cycle c can itself be decomposed into two business cycle phases: the expansion and the recession. In the remainder, we use the following notation: x^{ph} refers to the value of the series x for the business cycle phase ph, which can take two values $ph = \{ex, re\}$ where ex stands for expansion and re for recession. The duration of the business cycle satisfies $\tau_c = \tau_c^{ex} + \tau_c^{re}$ where τ_c^{ex} is the duration of the expansion phase and τ_c^{re} the duration of the recession phase. The peak of a typical business cycle is reached as of time τ_c^{ex}, which is the end of the expansion phase and the beginning of the recession phase, one quarter after. The trough of the cycle corresponds to the period $\left(\tau_c^{ex} + \tau_c^{re}\right)$, which is the end of the recession and the start of the next cycle, one quarter after. The phase ph represents the share $\pi^{ph} = \tau_c^{ph}/\tau_c$ of the duration of the cycle c for $ph = \{ex, re\}$.

The average growth rate of the real GDP for the panel of countries is denoted g and defined as $g \equiv \frac{1}{n}\sum_{i=1}^{n} g_i$, where g_i denotes the average growth for the economy i. The interest of the cycle dimension is to take into account potential differences between expansion and recession business cycle phases. To do so, we consider the growth rate for the cycle c in country i, which is denoted $g_{i,c}$ and defined as follows

$$g_{i,c} \equiv \pi_{i,c}^{ex} g_{i,c}^{ex} + \pi_{i,c}^{re} g_{i,c}^{re} \tag{1}$$

It is the average of the growth rates during the expansion and recession phases, respectively denoted $g_{i,c}^{ex}$ and $g_{i,c}^{re}$, weighted by the share of each business cycle phase in the full duration of the cycle, namely π^{ex} and π^{re} respectively. The averages of growth rates for each business cycle phase are defined as follows

$$g_{i,c}^{ex} \equiv \frac{1}{\tau_{i,c}^{ex}} \sum_{s=1}^{\tau_{i,c}^{ex}} g_{i,c,s}^{ex}, \text{ and } g_{i,c}^{re} \equiv \frac{1}{\tau_{i,c}^{re}} \sum_{s=\tau_{i,c}^{ex}+1}^{\tau_{i,c}} g_{i,c,s}^{re} \tag{2}$$

These definitions of growth are used hereafter to compute the elasticity of growth with respect to financial series.

As for the real GDP per capita, we define financial series in the cycle dimension: $F_{i,c,s}$ denotes the value of the financial series F measured for the quarter s of the cycle c in country i. We do not consider herein the specific cycles of the financial series – in Section 5 we consider explicitly the financial cycle as robustness checks. Then, the timing of expansion and recession of business cycle phases is the same as for the real GDP per capita. Actually, we are interested by the properties of business cycles in terms of financial activities. For each financial series, we consider its initial value at the beginning of each business cycle

$$\phi^{0}_{i,c} \equiv F_{i,c,0} \tag{3}$$

and its excess growth during the expansion phase

$$\phi^{ex}_{i,c} \equiv \log\left(F_{i,c,\tau^{ex}_{i,c}}/F_{i,c,0}\right)/\tau^{ex}_{i,c} - \bar{\phi}^{ex} \tag{4}$$

which is the quarterly average growth rate of the financial series during the expansion phase in deviation with respect to $\bar{\phi}^{ex}$, the average of growth rates for all the cycles of all the countries of the panel, namely

$$\bar{\phi}^{ex} \equiv (1/n)\sum_{i=1}^{n}\left(1/C^{i}\right)\sum_{c=1}^{C_i}\log\left(F_{i,c,\tau^{ex}_{i,c}}/F_{i,c,0}\right)/\tau^{ex}_{i,c} \tag{5}$$

where C^i represents the number of cycles observed for the economy i.

2.2. The Direct Elasticity between Growth and Excess Finance

The direct elasticity refers to the relationship between growth and excess finance for one typical business cycle without taking into account the interdependencies between business cycles.

Our methodology considers the elasticity between excess finance and growth to characterize the interactions between these two variables. To be more explicit, we are interested in the (semi-)elasticity[11] of the growth rate $g_{i,c}$ with respect to the measure of excess finance $\phi^{ex}_{i,c}$ during the cycle c in country i, which is given by the following first order partial derivative

$$\varepsilon^{D}_{\phi^{ex}_{i,c}} \equiv \frac{\partial g_{i,c}}{\partial \phi^{ex}_{i,c}} \tag{6}$$

Using the definition of $g_{i,c}$ provided by (1), the elasticity defined by (6) is equal to

$$\varepsilon^{D}_{\phi^{ex}_{i,c}} = \frac{\partial g^{ex}_{i,c}}{\partial \phi^{ex}_{i,c}}\pi^{ex}_{i,c} + \frac{\partial g^{re}_{i,c}}{\partial \phi^{ex}_{i,c}}\pi^{re}_{i,c} + \left(\frac{\partial \tau^{ex}_{i,c}}{\partial \phi^{ex}_{i,c}}\tau^{re}_{i,c} - \frac{\partial \tau^{re}_{i,c}}{\partial \phi^{ex}_{i,c}}\tau^{ex}_{i,c}\right)\frac{g^{ex}_{i,c} - g^{re}_{i,c}}{\left(\tau^{ex}_{i,c} + \tau^{re}_{i,c}\right)^2} \tag{7}$$

We use two regression with two different dependent variables to quantify the terms present in the equation (7). First regressions consider the growth rate during business cycle phases as a dependent

[11] Since both $g_{i,c}$ and $\phi^{ex}_{i,c}$ are the log of "gross" growth rates of real GDP per capita and the financial series, $\varepsilon^{g}_{\phi^{ex}}$ is the semi-elasticity between these two rates and the elasticity between these two "gross" rates. For simplicity, we use the term elasticity for in the remainder while keeping in mind that it concerns the "gross" rates of series.

variable and the second regressions consider the duration of business cycle phases as a dependent variable.

Growth regressions are estimated with the OLS estimator with fixed effects using the following specification

$$g_{i,c,s}^{ph} = c_g^{ph} + f_{g,i}^{ph} + \alpha_g^{ph}\phi_{i,c}^{ex} + \beta_g^{ph}\phi_{i,c}^{0} + \gamma_g^{ph}X_{i,c,s}^{g} + \varepsilon_{i,c,s} \tag{8}$$

for each phase $ph = \{ex, re\}$. In this regression, c_g^{ph} is the constant term, $f_{g,i}^{ph}$ a country-fixed effect, $X_{i,c,s}^{g}$ is a set of controls for both business cycles and growth, and α_g^{ph} the coefficient of interest that measures the elasticity between growth and excess finance during the business cycle phase $ph = \{ex, re\}$. We discuss below the consequences of the initial value of the financial series, associated with the coefficient β_g^{ph}, in terms of persistence. Using, (8) the elasticity of growth with respect to excess finance during the business cycle phase ph writes

$$\frac{\partial g_{i,c}^{ph}}{\partial \phi_{i,c}^{ex}} = \frac{1}{\tau_{i,c}^{ph}} \sum_{s=1}^{\tau_{i,c}^{ph}} \frac{\partial g_{i,c,s}^{ph}}{\partial \phi_{i,c}^{ph}} = \frac{1}{\tau_{i,c}^{ph}} \sum_{s=1}^{\tau_{i,c}^{ph}} \alpha_g^{ph} = \alpha_g^{ph} \tag{9}$$

for $ph = \{ex, re\}$.

For duration regressions, we use a parametric hazard model. The hazard is the probability of exiting from a state (for example, a recession or an expansion) conditional on the length of time in that state. Hazard models have been initially applied to the duration of business cycles by Sichel (1991) to assess whatever business cycles exhibit a positive duration dependence – in this case, periods of expansion or recession are more likely to end as they become older. Recently, Claessens et al. (2012) have extended this methodology to consider fixed effects and the influence of other variables for the probability of exiting from a business cycle phase. We then follow Claessens et al. (2012) to assess whatever our financial series influence the durations of recessions and expansions. Assuming that the duration $\tau_{i,c}^{ph}$ of the business cycle phase $ph = \{ex, re\}$ has a Weibull distribution[12], the logarithm of duration $\tau_{i,c}^{ph}$ can be estimated using the following specification[13]

$$\log\left(\tau_{i,c}^{ph}\right) = c_\tau^{ph} + f_{\tau,i}^{ph} + \alpha_\tau^{ph}\phi_{i,c}^{ex} + \beta_\tau^{ph}\phi_{i,c}^{0} + \gamma_g^{ph}X_{i,c}^{\tau} + z_{i,c}^{ph} \tag{10}$$

where $z_{i,c}^{ph}$ has an extreme-value distribution scaled by the inverse of the shape parameter of the Weibull distribution, denoted p^{ph}. In this regression, c_τ^{ph} is the constant term, $f_{\tau,i}^{ph}$ a country-fixed

[12]There is a great variety of parametric duration models, with the Weibull model the most commonly used for business cycle studies– see Diebold et al. (1993) for alternative specifications. The fundamental assumption of the Weibull model is a linear relationship between the log of the hazard function and the log of duration since the functional form for the hazard is $h(t) = pt^{p-1}$ where t is duration of the phase and p the Weibull parameter - there is positive duration dependence for $p > 1$.

[13]The assumption of a linear relationship between the log of duration and explanatory variables (both fixed effects and control variables) corresponds to the Accelerated Failure Time (AFT) specification of duration models with time-varying covariates; the alternative is the Proportional Hazard (PH) specification with multiplicative effects - see Jenkins (2005) for a discussion.

effect, $X^{\tau}_{i,c}$ is a set of controls for both business cycles and growth, and α^{ph}_{τ} the coefficient of interest. Using (10), the (semi-)elasticity of the duration of the business cycle phase ph with respect to excess finance is

$$\frac{\partial \tau^{ph}_{i,c}}{\partial \phi^{ex}_{i,c}} = \alpha^{ph}_{\tau} \tau^{ph}_{i,c} \tag{11}$$

for $ph = \{ex, re\}$.

The average value of $\varepsilon^{D}_{\phi^{ex}_{i,c}}$, defined by (7) for all the panel, is therefore

$$\varepsilon^{D}_{\phi^{ex}} = \frac{1}{n}\sum_{i=1}^{n}\frac{1}{C_i}\sum_{c=1}^{C^i}\left[\alpha^{ex}_{g}\pi^{ex}_{i,c} + \alpha^{re}_{g}\pi^{re}_{i,c} + \left(\alpha^{ex}_{\tau} - \alpha^{re}_{\tau}\right)\pi^{ex}_{i,c}\pi^{re}_{i,c}\left(g^{ex}_{i,c} - g^{re}_{i,c}\right)\right] \tag{12}$$

given the outcomes of the regressions (8) and (10). In the remainder, we use the variable $\sigma_{i,c} \equiv \pi^{ex}_{i,c}\pi^{re}_{i,c}\left(g^{ex}_{i,c} - g^{re}_{i,c}\right)$, which provides a measure of the gap in growth rates between the two business cycle phases, namely $(g^{ex}_{i,c} - g^{re}_{i,c})$, weighted by the relative duration of business cycle phases, $\pi^{ex}_{i,c}$ and $\pi^{re}_{i,c}$. Then, since the regression coefficients do not depend on the country i or the cycle c, the equation (12) becomes

$$\varepsilon^{D}_{\phi^{ex}} = \underbrace{\alpha^{ex}_{g} \times \bar{\pi}^{ex} + \alpha^{re}_{g} \times \bar{\pi}^{re}}_{\text{Growth Channel}} + \underbrace{\left(\alpha^{ex}_{\tau} - \alpha^{re}_{\tau}\right) \times \bar{\sigma}}_{\text{Duration Channel}} \tag{13}$$

where $\bar{x}$ denotes the historical mean of the series $x_{i,c}$ for $x = \{\pi^{ex}, \pi^{re}, \sigma\}$.

The elasticity of growth with respect to excess finance is the sum of three elements which are directly associated with business cycle properties. The sum of the first two elements constitutes the growth channel since it depends on the elasticities of growth during business cycle phases with respect to excess finance, namely α^{ex}_{g} and α^{re}_{g}, which are weighted by the relative shares of expansions and recessions in the business cycle duration, namely $\bar{\pi}^{ex}$ and $\bar{\pi}^{re}$. The third element constitutes the duration channel since it depends on the elasticities of business cycle phase durations with respect to excess finance, namely α^{ex}_{τ} and α^{re}_{τ}, and the weighted gap in the growth rates, which is measured by $\bar{\sigma}$. The duration channel does not exist if: the duration of business cycle phases are not correlated with excess finance ($\alpha^{ex}_{\tau} = \alpha^{re}_{\tau} = 0;$); or are correlated with excess finance, but the elasticity is the same for the two business cycle phases ($(\alpha^{ex}_{\tau} - \alpha^{re}_{\tau}) = 0$); or are correlated with excess finance, but the weighted gap in growth rates between the two business cycle phases is nul ($\bar{\sigma} = 0$).

2.3. The Total Elasticity between Growth and Excess Finance with Hysteresis

The total elasticity refers to the relationship between growth and finance when the interdependencies between business cycles are taken into account.

In the previous section, the interactions between economic growth and financial growth were considered within the same business cycle. However, current economic growth may also be related with past financial growth through persistent effects. To show how to compute these effects, we start with the definition of the law of motion of financial series for country i

$$\phi^0_{i,c+1} = \phi^0_{i,c}\left(1 + \bar{\phi}^{ex}\tau^{ex}_{i,c} + \phi^{ex}_{i,c}\tau^{ex}_{i,c} + \bar{\phi}^{re}\tau^{re}_{i,c} + \phi^{re}_{i,c}\tau^{re}_{i,c}\right) \tag{14}$$

where $\phi^0_{i,c+1}$, the initial value of the financial series for the cycle $(c+1)$, is equal to its initial value for the previous cycle, $\phi^0_{i,c}$, multiplied by the cumulative growth of the financial series during the previous expansion $(\bar{\phi}^{ex}\tau^{ex}_{i,c} + \phi^{ex}_{i,c}\tau^{ex}_{i,c})$ and recession $(\bar{\phi}^{re}\tau^{re}_{i,c} + \phi^{re}_{i,c}\tau^{re}_{i,c})$. $\phi^{re}_{i,c}$ is constructed as $\phi^{ex}_{i,c}$ in deviation with respect to the historical mean, see equations (4)-(5), but for the recession phase. If economic growth during the cycle $(c+1)$ is correlated with ϕ^0_{c+1}, it means that financial growth during the previous cycle, namely $\phi^{ex}_{i,c}$, has persistent effects for subsequent cycles. This situation can be interpreted as a hysteresis phenomenon.

Hysteresis is a popular concept to depict situations in which the consequences of an action persist even when this action is finished. In the previous section, the action considered was an excess in the growth rate of financial series. The elasticity $\varepsilon^D_{\phi^{ex}}$ provided captures the links between an excess finance and the business cycle during which this excess occurred. However, this excess can also have consequences for future cycles due to the hysteresis phenomenon. For example, an excessive growth of house prices during a cycle can lead to a high house price level at the beginning of the new cycle. In this case, even if housing prices are constant during this new cycle, the consequences of the previous cycle are still present through the initial value of housing prices.

To measure the persistent effect of excess finance on growth, we first define the elastisticy of growth with respect to the initial value of the financial series $\varepsilon^D_{\phi^0}$, which is the same as $\varepsilon^D_{\phi^{ex}}$ except that ϕ^0 is considered instead of ϕ^{ex}. Following the methodology exposed in the previous section, we get the following expression for $\varepsilon^D_{\phi^0}$

$$\varepsilon^D_{\phi^0} = \underbrace{\beta^{ex}_g \times \bar{\pi}^{ex} + \beta^{re}_g \times \bar{\pi}^{re}}_{\text{Growth Channel}} + \underbrace{(\beta^{ex}_\tau - \beta^{re}_\tau) \times \bar{\sigma}}_{\text{Duration Channel}} \tag{15}$$

the difference with (13) is that the coefficients β^{ph}_g and β^{ph}_τ of the regressions (8) and (10) are used instead of the coefficients α^{ph}_g and α^{ph}_τ. To measure the persistent effect of excess finance, this elasticity should be multiplied by the (semi-)elasticity of the initial value of the financial series with respect to the past value of excess finance, which is defined as

$$\frac{\partial \phi^0}{\partial \phi^{ex}_{-1}} \equiv \frac{1}{n}\sum_{i=1}^{n}\frac{1}{C_i}\sum_{c=1}^{C^i}\frac{\partial \phi^0_{i,c+1}}{\partial \phi^{ex}_{i,c}} \tag{16}$$

using the equations (11) and (14) – see appendix C for details. Finally, the elasticity of growth with respect to the excess finance in the previous cycle is

$$\varepsilon^H_{\phi^{ex}} \equiv \frac{\partial g}{\partial \phi^{ex}_{-1}} = \varepsilon^D_{\phi^0} \times \frac{\partial \phi^0}{\partial \phi^{ex}_{-1}} \tag{17}$$

which is interpreted hereafter as the hysteresis effect of excess finance, hence the label H.

Then, we can define the total elasticity between excess finance and growth that takes into account the hysteresis effect on growth. If the growth rate g depends on both the initial value of the financial series and the growth rate of these series, the total elasticity is

$$\varepsilon^T_{\phi^{ex}} = \varepsilon^D_{\phi^{ex}} + \varepsilon^H_{\phi^{ex}} \tag{18}$$

by taking the first order differential of the function $g\left(\phi^{ex}, \phi^0\right)$. Using the previous definitions of the elasticity $\varepsilon^D_{\phi^{ex}}$ and $\varepsilon^H_{\phi^{ex}}$, it can be expressed as the following combinations of regression coefficients and mean values

$$\begin{aligned}\varepsilon^T_{\phi^{ex}} \;=\; & \underbrace{\alpha^{ex}_g \times \bar{\pi}^{ex} + \alpha^{re}_g \times \bar{\pi}^{re}}_{\text{Direct Growth Channel}} + \underbrace{\left(\alpha^{ex}_\tau - \alpha^{re}_\tau\right) \times \bar{\sigma}}_{\text{Direct Duration Channel}} \\ & + \underbrace{\left[\beta^{ex}_g \times \bar{\pi}^{ex} + \beta^{re}_g \times \bar{\pi}^{re}\right] \times \frac{\partial \phi^0}{\partial \phi^{ex}_{-1}}}_{\text{Hysteresis Growth Channel}} + \underbrace{\left(\beta^{ex}_\tau - \beta^{re}_\tau\right) \times \bar{\sigma} \times \frac{\partial \phi^0}{\partial \phi^{ex}_{-1}}}_{\text{Hysteresis Duration Channel}}\end{aligned} \tag{19}$$

The total elasticity can be decomposed either by channel (duration vs growth) or by time horizon (direct vs hysteresis).

2.4. Estimating the Threshold

We define the initial level of financial series, denoted $\widehat{\phi}^0$, below which excess finance has a positive effect on growth even if we take into account the persistent effect. Then, the value for $\widehat{\phi}^0$ is such that $\varepsilon^T_{\phi^{ex}} = 0$, or equivalently, using equations (17)-(18), it satisfies

$$\frac{\partial \phi^0}{\partial \phi^{ex}_{-1}} = -\frac{\epsilon^D_{\phi^{ex}}}{\epsilon^D_{\phi^0}} \tag{20}$$

where the LHS term corresponds to the persistent effect of excess finance on the level of the financial series for the subsequent cycle and the RHS term to (minus of) the ratio elasticities of economic growth with respect to excess finance and to the initial value of the financial series. Using (16), it is equal to

$$\widehat{\phi}^0 = \frac{-\epsilon^D_{\phi^{ex}} / \epsilon^D_{\phi^0}}{\left(1 + \alpha^{ex}_\tau \bar{\phi}^{ex}\right) \overline{\tau}^{ex} + \left(\alpha^{re}_\phi + \alpha^{re}_\tau \overline{\phi}^{re}\right) \overline{\tau}^{re} + \alpha^{ex}_\tau \overline{\tau^{ex} \phi^{ex}} + \alpha^{re}_\tau \overline{\phi^{re} \tau^{re}}} \tag{21}$$

where the elasticities $\epsilon^D_{\phi^{ex}}$ and $\epsilon^D_{\phi^0}$ are computed as explained above and the coefficients α^{ph}_τ and α^{ph}_ϕ deduced from our regressions. For the variables with a bar, we take their average values in our sample of data.

3. Data

This section presents the financial and macroeconomic series (see Appendix A for details).

Financial Series. House price series are taken from the *International House Price Database* published by the Federal Reserve Bank of Dallas. Series are quoted in real terms and begin in first quarter 1975. Price to rent ratios are extracted from *OECD Housing Prices Database*. Price to rent ratio is the nominal house price divided by rent price. These quarterly series are available for the period 1970Q1-2014Q2. For credit series, we use BIS database entitled "Long series on credit to private non-financial sectors" which provides a measure of the total credit distributed to the non-financial corporations in nominal terms at the quarterly frequency for a large set of countries over the last decades. The definition of total credit used by the BIS is large and encompasses the credit provided by domestic banks and all other sectors of the economy including the non-residents. Credit is measured both as an index (the reference year is 2005) in real terms and as a ratio of GDP. The first measure is referred to as "Real Credit" and the second as "Credit to GDP" in the remainder of the paper. We use also the BIS database to build series of Credit to Households. This variable is measured both as an index in real terms and as a ratio of GDP (respectively "Households Credit" and "Households Credit to GDP"). All the variables used in this paper are described in Table A.3. The final panel encompasses a set of 26 countries[14] over the period 1970-2015.

Excess Finance. Following Jordà et al. (2013), we construct a measure of excess finance build-up during the previous boom: the rate of change in the series of finance, in deviation from its mean, and calculated from the previous trough to the subsequent peak. We use real house prices as the main specification for measuring "excess finance". As noticed by Jordà et al. (2016), housing finance has come to play a central role in the modern macroeconomy. Results are robust using other measures of excess housing developments such as price-to-rent ratios. We use also measures of excess credit such as Real Credit, Credit to GDP, Real Households Credit, Households Credit to GDP. Table A.1 provides the descriptive statistics of excess finance for our set of financial series.

Peaks and troughs. We apply the algorithm of Harding and Pagan (2002)[15] to identify local maxima (peaks) and minima (troughs) in the log-levels of real GDP per capita in each country of our panel. A cycle is composed of two phases: the expansion phase starts after a trough and ends at the peak which initiates the recession phases up to the next trough. The parameters of the algorithm are fixed such that a full cycle and each of its phase must last at least 4 quarters and

[14] Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Israel, Italy, Japan, South Korea, Luxembourg, The Netherlands, New Zealand, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, United Kingdom, United States.

[15] This algorithm constitutes a quarterly implementation of the original algorithm of Bry and Boschan (1971) for monthly series.

2 quarters, respectively. We identify in our series 249 peaks and 228 troughs. We only consider complete business cycles, that is a business cycle with an expansion and a recession. We thus keep 228 GDP cycles. Table A.2 provides the descriptive statistics of business cycles.

4. Results

We present in this section the results and then propose simulations of GDP patterns depending on variations in excess finance.

4.1. Regression results

GDP growth. Table 2 shows regressions between House Prices and real GDP growth. We start with no controls in the first columns and add controls moving to the right in the table. For a house price excess of 1%, GDP increases by 0.07 points of percentage during expansions (column (1)). As expected, the intensity of the housing boom during the expansion phase is closely associated with the severity of the recession phase. A 1% excess in house prices growth during the expansion is associated with a reduction of GDP growth by 0.08 points of percentage (column (2)). We control these results using the traditional determinants of long-run growth used in the literature, among them the state of development of the country at the beginning of each business cycle measured by the real GDP per capita, the state of development of the financial sector measured with the credit to GDP ratio at the beginning of each business cycle, population growth and the average years of schooling of population aged 25 and over (see in particular Levine (1997) or more recently Cecchetti and Kharroubi (2012)). Results confirm the positive elasticity during the expansion and the negative elasticity during the recession (columns (4) and (5)). Excess financial growth and economic growth move together both during expansions and recessions, but in opposite direction. For the expansion phases, this is consistent with the well-known procyclical behaviour of finance and, for the recession phases, it confirms the recent results reported by Drehmann et al. (2012), Claessens et al. (2012) and Jordà et al. (2013).

Table 2 shows another interesting result on the interactions between finance and growth when it comes to the initial condition. The coefficient of the initial value of house prices is negative for the two business cycle phases, the expansion and recession (columns (1)-(2)). This result seems in contradiction with the literature on long-run growth which precisely showed that the initial state of financial development can be a good predictor for future economic growth, see Levine (1997). However, we consider here a very specific initial condition, namely the value of house prices at the end of the previous cycle, which is the inheritance of the previous cycle. If one consider periods of five or ten years, as generally considered in the literature, the initial state of financial development is positively correlated with subsequent economic growth. Hence, the originality of our methodology. Then, starting a new cycle with a high level of house prices is associated with a low economic growth, not only during the new expansion phase, but also during the next recession. This effect holds even if we introduce the controls for economic growth in columns (4)-(5). This result can be related with the concept of "Debt Supercycle" developed by Rogoff (2015) according to which the inheritance of excessive development of finance in the past can lead to long-lasting low economic growth (see also Lo and Rogoff (2015)). This result could also be linked to the notion of deleveraging crisis formalized by Eggertsson and Krugman (2012). They present a new Keynesian model of debt-driven slumps – that is, situations in which an overhang of debt on the part of some agents, who are forced into rapid deleveraging, is depressing aggregate demand.

Table 2 – House Prices and GDP growth

	(1) GDP (OLS)	(2) GDP (OLS)	(3) GDP (OLS)	(4) GDP (OLS)	(5) GDP (OLS)	(6) GDP (OLS)
Period	Expansion	Recession	Cycle	Expansion	Recession	Cycle
House Prices(Excess)	0.0673***	-0.0757***	0.0302***	0.0921***	-0.0744***	0.0555***
	(0.0115)	(0.0198)	(0.0102)	(0.0130)	(0.0231)	(0.0120)
House Prices[0]	-5.46e-05***	-4.48e-05***	-5.97e-05***	-4.85e-05***	-6.05e-05***	-6.24e-05***
	(6.95e-06)	(1.18e-05)	(6.23e-06)	(1.18e-05)	(2.04e-05)	(1.08e-05)
Schooling				0.000145	-0.000248	-4.28e-05
				(0.000126)	(0.000257)	(0.000122)
Credit/GDP[0]				-0.00135**	0.00309***	0.00121*
				(0.000690)	(0.00118)	(0.000624)
Population				-0.214***	-0.280***	-0.312***
				(0.0412)	(0.0655)	(0.0368)
GDP capita[0]				-1.13e-09***	-2.10e-10	-1.30e-09***
				(1.78e-10)	(5.92e-10)	(1.76e-10)
Constant	0.00943***	0.00401***	0.00866***	0.0116***	0.00552***	0.0105***
	(0.000502)	(0.000878)	(0.000454)	(0.00103)	(0.00201)	(0.000983)
Observations	2,273	760	3,033	1,809	633	2,442
R^2	0.051	0.032	0.037	0.121	0.084	0.083
Number of country	21	21	21	20	20	20

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Country fixed effects included. GDP is GDP per capita quarterly growth. "Excess" stands for excess financial growth. "[0]" indicates the level at the beginning of each business cycle.

Duration. In Table 3, we employ the Weibull regression model to investigate the role of excess finance as a determinant of the duration of the different phases of business cycles (Section 2.2). In line with the literature, results of our regressions first show a positive duration dependence (P(Weibull distribution parameter)> 1) (columns (1) to (6)), which implies that an expansion (recession) is more likely to end the longer it lasts (see in particular Claessens et al. (2012)). We then show that large excess house prices are associated with a longer duration of expansions (column (1)) while they are not significantly correlated with the duration of the recession in the case of excess house prices (column (2)). These results are robust using the controls (columns (4) and (5)). The coefficient of the initial value of house prices is negative and significantly different from zero (column (2)) but it is no longer significant when controls are introduced (column (5)).

To our knowledge, the identification of a link between finance and expansion duration is a new contribution to the literature. This result was previously suggested by Terrones et al. (2009) which show with summary statistics that duration of the expansion is longer for business cycles with financial crisis with no clear predictions for the economic growth. Jordà et al. (2013) suggest also with descriptive statistics that the duration of expansion is longer for expansions with high excess credit than for expansions with low excess credit. The literature on the links between financial cycles and business cycles do not focus on the duration of expansions. They study recessions and recoveries. For instance, Claessens et al. (2012) examine how the growth of asset prices prior to the recession correlates with the recession's duration. In their regressions, the increase in house prices prior to the recession is significantly positively related with the recession's duration, while equity price growth does not have a significant correlation. They do not study the duration of expansions since the amplitude of a recovery is measured over a fixed period of four quarters.

Table 3 – House Prices and Duration

	(1) Duration (Weibull)	(2) Duration (Weibull)	(3) Duration (Weibull)	(4) Duration (Weibull)	(5) Duration (Weibull)	(6) Duration (Weibull)
Period	Expansion	Recession	Cycle	Expansion	Recession	Cycle
House Prices (Excess)	19.39***	6.025	17.65***	20.54***	7.685	18.70***
	(4.588)	(4.770)	(3.913)	(5.699)	(6.400)	(4.773)
House Prices[0]	-0.00164	-0.00458**	-0.00179	-0.00640**	-0.00524	-0.00595**
	(0.00223)	(0.00211)	(0.00177)	(0.00315)	(0.00332)	(0.00249)
Schooling				-0.0911*	-0.0695	-0.0785**
				(0.0484)	(0.0470)	(0.0366)
Credit/GDP[0]				-0.208	0.139	-0.146
				(0.177)	(0.189)	(0.135)
Population				71.08	9.613	55.01
				(76.20)	(59.64)	(57.01)
GDP capita[0]				1.46e-07**	-8.96e-08	1.22e-07**
				(6.55e-08)	(5.81e-08)	(5.35e-08)
Observations	155	155	155	108	108	108
Number of countries	22	22	22	20	20	20
P (Weibull distribution para.)	1.225	1.333	1.528	1.311	1.368	1.685

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Country fixed effects included. "Excess" stands for excess financial growth. "[0]" indicates the level at the beginning of each business cycle. "Duration" stands for the duration (in quarters) of each phase of the business cycle.

4.2. Elasticities

Regression results show several interactions between excess finance and the characteristics of the expansions and recessions, namely their growth rates and durations. This section uses our methodology to determine the implications of these interactions on economic growth. To do so, we apply the formulas presented in Section 2 for the estimates of the coefficients α_x^{ph}, β_x^{ph} which are significantly different form zero at the 10% level, otherwise the zero value is imposed, where $ph = \{ex, re\}$ and $x = \{g, \tau\}$.

In Table 4, we measure GDP growth elasticity with respect to house prices (excess). Column (7) reports total elasticity as the sum of the growth channel (columns (1) to (3)) and the duration channel (columns (4) to (6)) in three cases: (a) the direct effect where we only measure the contemporaneous effect of excess finance, (b) taking into account only the persistent effect of excess finance, (c) the total effect.

For the direct effect (a), we estimate equation (13) of Section 2.2 that measures the elasticity between growth and excess finance for a complete business cycle. Concerning the growth channel, the total elasticity is equal to 3.08% (column (3)), a number that is the sum of the elasticities during the expansion (that is 5.01%, column (1)) and the recession (that is -1.93%, column (2)). The value of $\bar{\pi}^{ex}$ introduced in equation (13) for our panel is 0.745, that is economies are in average three quarters of the time in expansion and one quarter of the time in recession. This explains why the growth channel is positive even if the negative coefficient of excess finance for recessions in Table 2 is larger in absolute value than the positive coefficient of excess finance for expansions. The gap between the growth channel and the total direct elasticity is explained by the duration channel, which is equal to 0.36% (column (6)) and therefore accounts for almost 11% of the direct elasticity. The duration channel is positive because excess finance is associated with longer duration of expansion and as the economic growth is in average higher in expansions than in recessions – the corresponding rates are 2.19% and -0.11%.

We measure in line (b) of Table 4 the persistent effect of excess finance. We use equation (17) in Section 2.3. The elasticity is negative (-6.01%, column (7)), mainly because of a negative elasticity for the growth channel. The elasticity for the growth channel is indeed equal to -6.11% (column (3)), a number that is the sum of the elasticities during the expansion (namely -4.877%, column (1)) and the recession (namely -1.34%, column (2)).

We then measure in line (c) of Table 4 the total elasticity between growth and excess finance. To estimate this elasticity, we use equation (19) of Section 2.3. This total elasticity is the sum of the direct elasticity (line (a)) and of the persistent effect of excess finance calculated in line (b). We find a negative total elasticity (-2.58%, column (7)). Interestingly, this negative effects mainly comes from a negative effect for the growth channel during the recession period ((-3.28%, column (2))). The growth-channel effect during the expansion is comparatively rather small ((0.25%, column (1))). The duration channel has a positive effect on the total elasticity ((0.46%, column (6))). It accounts for almost 18% of the total elasticity.

We finally compute the threshold given in Section 2.4. It measures the initial level of financial series until which excess finance has a positive effect on growth. For house prices, the threshold is equal to 40% of the average value of house prices in the sample (Table A.12). It means that a high value for excess finance is accompanied by a high level of economic growth during a typical business cycle but can be offset in the subsequent cycle given the persistent effect of excess finance. If the subsequent cycle starts with a low level of financial series, the total effect remains positive. For most economies of our panel, the average value of the financial series is above this threshold suggesting that the total effect of excess finance on growth is negative.

Table 4 – Elasticities for House Prices (Excess)

	(1) Growth(ex)	(2) Growth(re)	(3) Growth(tot)	(4) Dura(ex)	(5) Dura(re)	(6) Dura(tot)	(7) Total
(a) Direct elasticity	5.01	-1.93	3.08	0.36	0.00	0.36	3.43
(b) Persistent effects	-4.77	-1.34	-6.11	0.00	0.10	0.10	-6.01
(c) Total elasticity	0.25	-3.28	-3.03	0.36	0.10	0.46	-2.58

Notes: We measure GDP growth elasticity with respect to Excess House Prices. "Growth(ex)", "Growth(re)", "Growth(tot)" are the GDP growth channels during expansion, recession and for the complete business cycle. "Dura(ex)", "Dura(re)", "Dura(tot)" are the duration channels during expansion, recession and for the complete business cycle. "Total" measures the direct elasticity (a), the elasticity taking only into account persistent effects of excess finance (b), the total elasticity (c).

4.3. Simulating Growth Pattern for Various Excess Finance

As an illustration of our results, we propose now simulations of GDP patterns associated with different paths of financial series, including the case of financial bubbles. To do so, we compute the cumulative growth of output for the cycle c as $G_c\left(\phi_c^{ex}, \phi_c^0\right) \equiv \log\left(Y_c/Y_{c-1}\right)$. Using the outcome of the regressions and the average values of the panel (with the bar symbol), it can be expressed as follows

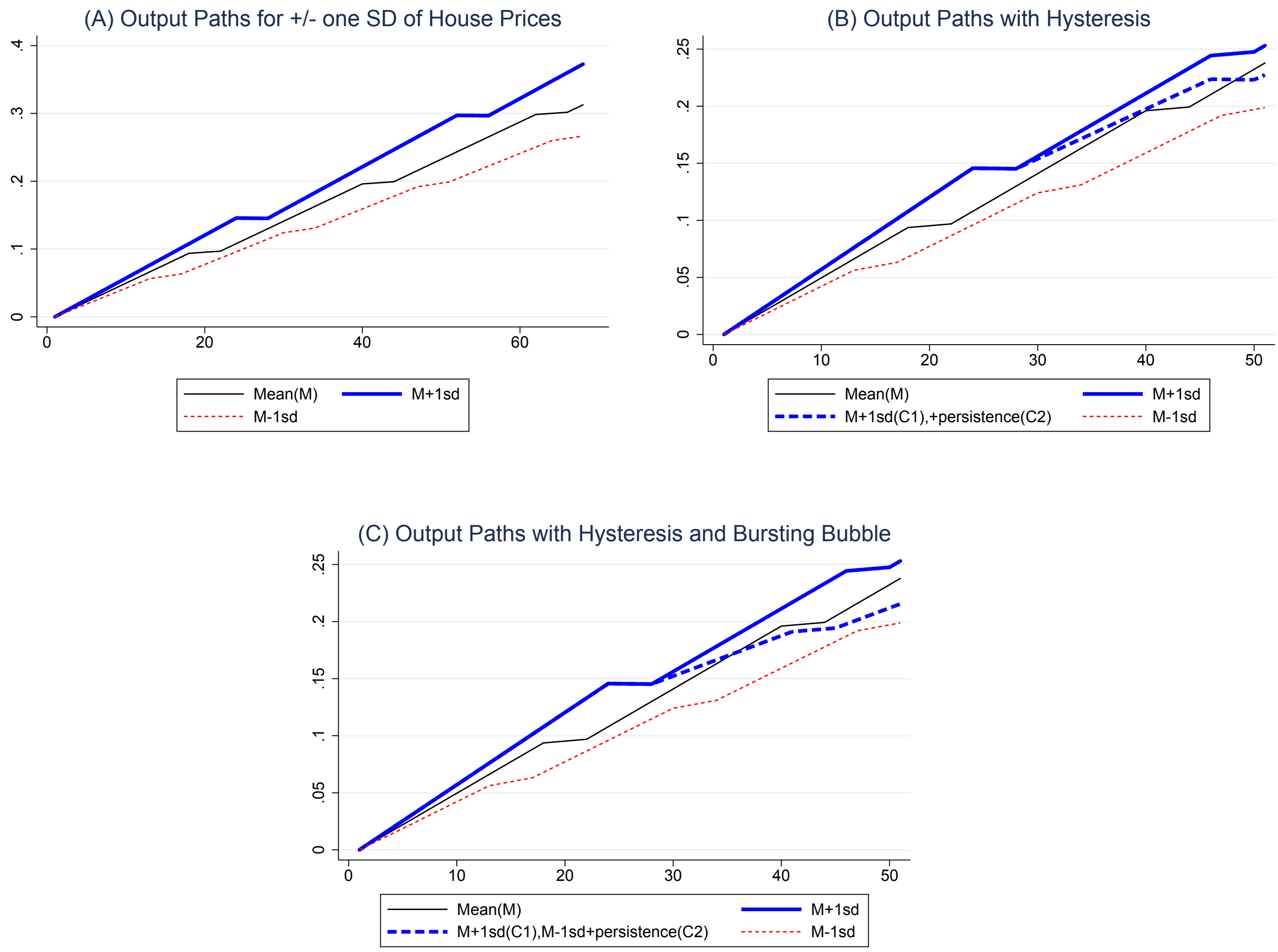
$$\begin{aligned} G_c\left(\phi_c^{ex}, \phi_c^0\right) \;=\; & \left(\overline{\tau}^{ex} + \alpha_\tau^{ex}\phi_c^{ex} + \beta_\tau^{ex}\phi_c^0\right)\log\left(1 + \overline{g}^{ex} + \alpha_g^{ex}\phi_c^{ex} + \beta_g^{ex}\phi_c^0\right) \\ & + \left(\overline{\tau}^{re} + \alpha_\tau^{re}\phi_c^{ex} + \beta_\tau^{re}\phi_c^0\right)\log\left(1 + \overline{g}^{re} + \alpha_g^{re}\phi_c^{ex} + \beta_g^{re}\phi_c^0\right) \end{aligned} \tag{22}$$

The interest of these simulations is to exhibit the role of direct interactions (between excess finance and growth) and indirect interactions (through persistent effects on the initial values of financial series). In Figure 2, we simulate GDP patterns depending on various scenarios for the growth rate and the initial values of excess house prices which are summarized in Table A.13.

To start, we consider only the direct interactions between excess finance and growth. Figure 2A shows output paths for business cycles with high excess house prices (corresponding to the mean value of excess house prices plus one standard deviation), for the mean value of excess house prices, and for low excess house prices (mean minus one standard deviation). GDP growth is larger during the expansion for high excess house prices. The duration of the expansion is also longer for high excess house prices. Total GDP growth is thus much larger with high excess house prices than with low excess house prices, even if growth is lower during recessions with high excess finance.

Then, we take into account the persistent effects of excess finance by considering that the initial value of the financial series for the second cycle is impacted by the excess finance of the first cycle as specified in equation (14). Figure 2B reproduces the three output patterns of Figure 2A and adds the case of high excess finance with this persistent effect. Following a business cycle with a high excess house prices, GDP growth is reduced in the following cycle because of the high initial value of

Figure 2 – SIMULATION OF OUTPUT PATHS FOR VARIATIONS IN EXCESS HOUSE PRICES



Notes: Figure 2A shows output paths for business cycles with high excess house prices (corresponding to the mean value of excess house prices plus one standard deviation ("M+1sd", *in blue*), for the mean value of excess house prices ("M", *in black*), and for low excess house prices (mean minus one standard deviation, *in red*). Figure 2B reproduces the three output patterns of Figure 2A and adds the case of high excess finance with a persistent effect in cycle 2 ("C2", *Blue dash-line*). Figure 2C shows the case of a first cycle ("C1") with a high excess house prices followed by a cycle with persistent effects on the initial values of house prices and a low excess house prices (Mean minus one standard deviation, "M-1sd+persistence(C2)", *Blue dash-line*) – the three benchmark paths of the Figure 2A are also reproduced. We show coefficients that are significantly different form zero at the 10% level, otherwise the zero value is imposed.

house prices. The initial value of house prices (that is the value of house prices at the beginning of each business cycle) is indeed negatively correlated with GDP growth (Table 2). At the end of the first cycle, output is higher in the high excess finance case, but it is not necessary the case at the end of the subsequent cycles. Indeed, for this simulation, the solid blue lines overtakes the dotted blue line at the end of the period.

Finally we consider output paths in the case of a bursting bubble. Financial bubble is a very large concept to describe situations in which market prices diverge lastingly from their fundamental or equilibrium values in such a way that market corrections should occur to restore market equilibrium. In our data, financial growth is defined for financial series that try to capture such divergence, as the price-to-rent ratio and credit-to-ouput. However, it is hard to distinguish in the data the fluctuations of theses series that result from structural shifts of the economy from those that result from purely bubble/speculative behaviors. Nevertheless, our methodology can be informative to characterize the pattern of economic growth associated with a financial bubble. Once again, we do not measure here the causal impact of a financial bubble on economic growth, but we identify the joint behavior of economic and financial growth during business cycles. More precisely, we describe the pattern of financial bubbles as exhibited in Table A.14, that is by the alternation of positive and negative values for excess finance – see for example the cases of France, Spain or the United Kingdom. We propose to simulate the consequences of a bubble defined as follows

$$\phi_c^{ex} = \begin{cases} \mathrm{sd}\left(\phi^{ex}\right) & \text{, if } c = \widetilde{c} \\ -\delta \times \mathrm{sd}\left(\phi^{ex}\right) & \text{, if } c = \widetilde{c} + 1 \\ 0 & \text{otherwise} \end{cases} \tag{23}$$

where sd is the standard deviation of the financial series considered and δ is the size of the contraction of the bubble. Figure 2C shows the case of a first cycle with a high excess house prices followed by a cycle with persistent effects linked to the initial values of house prices and a low excess house prices (Mean minus one standard deviation) – the three benchmark paths of the Figure 2A are also reproduced. This corresponds to a bursting bubble. GDP growth is much reduced in this case because of the combination in the second cycle of low house prices growth and a high initial value of house prices. In Figure 2C, we consider $\delta = 1$. In practice, we can observe situation where there is no full deleveraging ($\delta < 1$). This situation is close to numerous examples of growth during and after financial bubbles (as recently observed in Spain, see Table A.14). The interest of our methodology is to generate such patterns using estimates of growth-finance interactions through the growth and duration channels as well as the persistent effects of financial growth.

5. Robustness Checks

We propose robustness checks of the main results of the paper. We show that our regression results are roughly the same for other measures of excess finance. We show that our results are robust to controlling for endogeneity as recently suggested by Arcand et al. (2015). We control also our results for properties of the financial cycle and for the occurrence of bank crisis. We finally test the hypothesis that the hysteresis effect could come from the link between finance and productivity.

5.1. Alternative measures of finance

We choose as the main specification house price excess. As robustness checks, we use five other measures of excess finance growth such as price-to-rent ratios, real credit, credit to GDP, real households credit, households credit to GDP.

Regression results for five alternative measures. The correlation between excess finance and GDP growth is very robust in expansion and recession for the five alternative measures. Price-to-rent ratios (excess), real credit (excess), credit to GDP (excess), real households credit (excess), households credit to GDP (excess) are all associated with higher GDP growth during the expansion and lower growth during the recession (columns (1) and (2) of Tables A.4, A.5, A.6, A.7, A.8). In contrast, the coefficients of correlation between economic growth and the initial values of all these financial series are robustly negative and significantly different from zero both for expansions and recessions. Concerning duration, the five different measures of excess finance growth indicate a strongly positive and significant correlation between excess finance growth and the duration of the expansion phase (columns (3) of Tables A.4, A.5, A.6, A.7, A.8). We find also a positive and significant correlation between excess finance growth and the duration of the recession in the case of credit to GDP (column (9) of Table A.6).

Elasticities for five other measures. In Table A.9, we report the direct elasticities for to the six measures of excess finance. Column (7) reports the elasticity as the sum of the growth channel (columns (1) to (3)) and the duration channel (columns (4) to (5)). For five out of the six measures of excess finance, the direct elasticity is positive. This is the case for house prices, price-to-rent ratio, real credit, real households credit and households credit to GDP (the only exception is the ratio of credit to GDP). When the persistent effect of excess finance is considered, in Table A.10, the elasticity is negative for all series considered with a range of values between -5.31 (for the Real Credit series) and -9.35 (for the ratio of household credit to GDP). Given these figures, the persistent effect clearly outweighs the direct effect making the total effect negative for all series, see Table A.11. We compute also the threshold $\widehat{\phi}^0$ for each financial indicator in Table A.12. In average for our six measures of excess finance, this threshold corresponds to a third of the level of the financial series observed in our sample in 2014-2015 or to 50% of the average level of financial series. The fact that the average level of the financial series is well above this threshold explains the negative elasticity between finance and growth we compute in Table A.11.

5.2. Endogeneity

Regressions in Section 4.1 show significant correlation between excess finance and growth even if we control for country fixed-effects and other determinants of economic growth as originally done by King and Levine (1993). However, as emphasized by Beck (2009), OLS estimators may not be consistent because of the omitted variable bias, the reverse causation from growth to excess finance, and measurement issues of variables. Instrumental Variables (IV) have been extensively used in the growth-finance literature to overcome the biases of OLS estimators notably by instrumenting financial depth with legal origin in cross-country analysis (Levine (1998), Levine (1999)) or by using lagged variables as internal instruments in dynamic panel analysis (Beck et al. (2000)). We follow the strategy recently proposed by Arcand et al. (2015) who use an identification strategy based on the presence of heteroskedasticity in the regression's residual. The interest of this methodology originally developed by Rigobon (2003) and Lewbel (2012) is to improve the identification of causal relationships even in the absence of external instruments[16] - see Appendix B for details on the identification strategy. Table 5 reports the estimates of the models of Tables 2 (columns (4), (5), and (6)) using identification through heteroskedasticity (Rigobon (2003), Lewbel (2012))[17]. As in the OLS estimations of Table 2, we find a positive relationship between House Prices (Excess) and GDP growth during the expansion (column (1)) and a negative one during the recession (column (2)). The coefficients associated with House Prices (Excess) are precisely estimated, suggesting that $\operatorname{cov}(X, \varepsilon_2^2)$ is not close to zero and the Hansen's J test fails to reject the overidentifying restrictions at the 5% confidence level.

5.3. Controlling for the Financial Cycle and for Banking Crises

We control our results more precisely for the Financial cycle and for the occurrence of Banking Crises.

Controlling for the Financial Cycle. In our benchmark regressions, we consider the value of financial series without taking into account the cycle of these series. In Table 6, we show that our results are robust controlling more precisely for the financial cycle. To define the financial cycle, we apply the algorithm of Harding and Pagan (2002) to identify local maxima (peaks) and minima (troughs) in the log-levels of real house prices in each country of our panel[18]. A financial cycle is composed of two phases: the financial boom phase starts after a trough and ends at the peak which initiates the financial bust phases up to the next trough. We create a financial bust dummy, equal to 1 during a financial bust and to 0 during a financial boom.

[16] As explained by Beck (2009), the challenge with external instruments "is to identify the economic mechanisms through which the instrumental variables influence the endogenous variable – financial activity – while at the same time assuring that the instruments are not correlated with growth directly."

[17] We cannot use the same methodology for the Weibull regression model we use in Table 3. In this section, we thus choose to focus on controlling the endogeneity of the OLS regressions.

[18] We define the financial cycle using real house prices as this variable is the main specification in our paper.

Table 5 – Correcting for Endogeneity

	(1) GDP growth (IV)	(2) GDP growth (IV)	(3) GDP growth (IV)
Period	Boom	Recession	Cycle
House Prices (Excess)	0.0681***	-0.135**	0.0375**
	(0.0155)	(0.0610)	(0.0173)
House Prices[0]	-5.75e-05***	-6.72e-05***	-5.68e-05***
	(1.47e-05)	(2.27e-05)	(1.24e-05)
Schooling	8.93e-05	-0.000455	1.18e-05
	(0.000140)	(0.000281)	(0.000126)
Credit/GDP[0]	-0.00133	0.00375***	0.000194
	(0.000993)	(0.00134)	(0.000828
Population	-0.0893	-1.430***	-0.681***
	(0.208)	(0.391)	(0.196)
GDP capita[0]	-1.01e-09***	-8.22e-10*	-1.22e-09***
	(2.64e-10)	(4.32e-10)	(2.42e-10)
Observations	1,909	514	2,423
Hansen J Stat.	2.849	6.145	0.404
p-value	0.583	0.189	0.982

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Country fixed effects included. "Excess" stands for excess financial growth. "[0]" indicates the level at the beginning of each business cycle. "GDP growth" is GDP per capita quarterly growth. The causal effect of House Prices (Excess) is identified using identification through heteroskedasticity (Lewbel (2012)).

In columns (1) and (2) of the Table 6, we first verify that financial busts are indeed negatively correlated with GDP growth. As expected, this is the case both during business cycle expansions (column (1)) and recessions (columns (2)). We then show that our main results described in Table 2 are robust controlling for the financial cycle: excess finance is positively correlated with GDP during the expansion (column (3)) and negatively correlated during the recession (column (4)). As in Table 2, the coefficient of the initial value of the financial series is also negative for the two business cycle phases, the expansion and recession. The duration regressions are also robust controlling for the financial cycle (see Table 3). In particular, large excess house prices are associated with a longer duration of expansions (column (7)).

Finally, instead of using our standard measure of excess finance (defined from a business cycle trough to a business cycle peak), we define excess finance specifically for the financial boom period (that is, from a financial cycle trough to the financial cycle peak). Excess finance is positively correlated with GDP growth during the business cycle expansion (column (5)), and negatively correlated during the recession (column (6)). The coefficient during the recession is however weakly significant (17% level). We define also the initial value of the financial series with respect to the financial cycle: as previously, we find a negative correlation with GDP growth both during the expansion (column (5)) and the recession (column (6)).

Financial crises Banking crises could be the culprits that lie behind the persistent effect of excess finance. In table 7, we test this prediction. We first show that the main results of the paper are robust controlling for a Banking crisis dummy. In particular, during expansion periods, excess house prices are positively correlated with GDP growth (column (1)) and to the duration of expansion (column (3)). The initial level of house prices is negatively correlated both with GDP growth and with the duration of expansion. These two variables are not correlated during recessions (columns (2) and (4)). We find the same results when adding interaction terms between Excess House Prices and the banking crisis dummy or between House Prices [0] and the banking crisis dummy. These two interaction terms are not significant (columns (5) and (6)). These results seem to indicate that banking crises do no explain the persistent effect of excess finance. Similarly, our results do not seem specific to bank crisis periods.

Table 6 – Controlling for the Financial Cycle

	(1) GDP (OLS)	(2) GDP (OLS)	(3) GDP (OLS)	(4) GDP (OLS)	(5) GDP (OLS)	(6) GDP (OLS)	(7) Duration (Weibull)	(8) Duration (Weibull)
Period	Expansion	Recession	Expansion	Recession	Expansion	Recession	Expansion	Recession
House Prices (Excess)			0.0443***	-0.141***			16.13***	14.49**
			(0.0146)	(0.0267)			(5.799)	(6.134)
House Prices[0]			-4.24e-05***	-9.21e-05***			-0.00980***	-0.00423*
			(1.20e-05)	(2.45e-05)			(0.00262)	(0.00250)
Housing bust (dummy)	-0.00309***	-0.00445***	-0.00178***	-0.00377***	-0.00256***	-0.00294***	0.309*	0.254
	(0.000323)	(0.000671)	(0.000348)	(0.000679)	(0.000337)	(0.000915)	(0.158)	(0.159)
House Prices(Excess, Fin. cycle)					0.129***	-0.0684		
					(0.0250)	(0.0497)		
House Prices [0, Fin. cycle]					-3.22e-05***	-5.46e-05*		
					(1.20e-05)	(2.82e-05)		
Schooling			-2.46e-05	-3.76e-05	0.000194	-0.000456		
			(0.000134)	(0.000289)	(0.000143)	(0.000332)		
Credit/GDP[0]			-0.00156**	0.00316**	-0.00166**	0.00259*		
			(0.000689)	(0.00132)	(0.000644)	(0.00136)		
Population			-0.263***	-0.196***	-0.281***	-0.289***		
			(0.0433)	(0.0697)	(0.0431)	(0.0755)		
GDP capita[0]			-1.78e-09**	-2.73e-09	-3.73e-09***	2.68e-09		
			(8.45e-10)	(2.29e-09)	(1.27e-09)	(4.82e-09)		
Constant	0.00643***	0.00396***	0.0131***	0.00835***	0.0112***	0.00815***		
	(0.000162)	(0.000499)	(0.00105)	(0.00232)	(0.00120)	(0.00303)		
Observations	1,657	506	1,490	475	1,256	400	104	104
R-squared	0.053	0.083	0.153	0.184	0.158	0.104		

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Country fixed effects included. "Excess" stands for excess financial growth. "[0]" indicates the level at the beginning of each business cycle. "GDP" is GDP per capita quarterly growth. "House Prices(Excess, Fin. cycle)" stands for excess financial growth defined with respect to the housing cycle. "Housing bust (dummy) " is a dummy equal to 1 during housing bust and equal to 0 during housing boom.

5.4. Finance and productivity

The link between finance and productivity could be an explanation of the hysteresis effect of excess finance. According to Cecchetti and Kharroubi (2015) and Borio et al. (2016), credit booms tend to undermine productivity growth by inducing labour reallocations towards lower productivity growth sectors, in particular the construction sector. The financial sector's expansion may indeed benefit disproportionately to projects with high collateral but low productivity. This could explain the negative effect of the excessive development of finance inherited from previous cycles. Testing fully this hypothesis is beyond the scope of this paper. However, we show in Table 8 that during expansions, if excess finance is positively correlated with GDP growth (columns (1) and (5) for House prices (excess) and Credit (excess)), it is negatively correlated with total factor productivity (TFP) growth (columns (2) and (6)). The initial level of financial activity is also negatively correlated with TFP growth. We show also that during recessions, excess finance is negatively correlated with TFP growth (columns (4) and (8)). These results could suggest that financial booms affect negatively productivity with long-term consequences on GDP growth.

Table 7 – Controlling for Banking Crises

	(1) GDP growth (OLS)	(2) GDP growth (OLS)	(3) Duration (Weibull)	(4) Duration (Weibull)	(5)) GDP growth (OLS)	(6) GDP growth (OLS)
Period	Expansion	Recession	Expansion	Recession	Expansion	Recession
House Prices (Excess)	0.0823***	-0.0125	20.29***	8.912	0.0822***	0.0152
	(0.0201)	(0.0607)	(4.307)	(8.226)	(0.0269)	(0.0688)
House Prices[0]	-7.48e-05***	-1.46e-05	-0.00897**	-0.000891	-7.51e-05***	-2.40e-05
	(2.03e-05)	(5.19e-05)	(0.00394)	(0.00542)	(2.12e-05)	(4.73e-05)
Schooling	1.54e-05	-0.000427	-0.0269	-0.0620	1.51e-05	-0.000111
	(0.000154)	(0.000595)	(0.0531)	(0.0569)	(0.000156)	(0.000627)
GDP capita[0]	-1.17e-09***	-9.12e-10*	1.60e-07**	-1.30e-07**	-1.16e-09***	-6.84e-10
	(1.91e-10)	(4.66e-10)	(6.97e-08)	(5.54e-08)	(2.32e-10)	(4.49e-10)
Credit/GDP[0]	7.73e-05	0.00546**	-0.485*	-0.203	6.71e-05	0.00393
	(0.000821)	(0.00210)	(0.260)	(0.335)	(0.000810)	(0.00232)
Population	-0.124	-2.157*	39.87	-38.39	-0.121	-1.891*
	(0.265)	(1.192)	(94.28)	(79.41)	(0.275)	(0.985)
Bank Crisis	0.000723	-0.00489**	0.662***	0.350	0.000644	-0.00663
	(0.000644)	(0.00192)	(0.164)	(0.223)	(0.00208)	(0.00486)
House Prices (Excess)*Crisis					0.000916	-0.168
					(0.0524)	(0.159)
House Prices[0]*Crisis					1.19e-06	2.18e-05
					(2.54e-05)	(5.73e-05)
Observations	1,467	384	71	71	1,467	384
P (Weibull distribution para.)			1.677	1.360		

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Country fixed effects included. "Excess" stands for excess financial growth. "[0]" indicates the level at the beginning of each business cycle. "GDP" is GDP per capita quarterly growth. "Bank Crisis " is a dummy equal to 1 if there is a banking crisis at any date during the cycle.

Table 8 – Excess Finance and Productivity

	(1) GDP (OLS)	(2) TFP (OLS)	(3) GDP (OLS)	(4) TFP (OLS)	(5) GDP (OLS)	(6) TFP (OLS)	(7) GDP (OLS)	(8) TFP (OLS)
Period	Expansion	Expansion	Recession	Recession	Expansion	Expansion	Recession	Recession
House Prices (Excess)	0.0835***	-0.145***	-0.118***	-0.323***				
	(0.0206)	(0.0401)	(0.0382)	(0.0736)				
House Prices[0]	-5.31e-05***	-0.000106***	-6.88e-05***	-0.000267***				
	(8.68e-06)	(1.69e-05)	(1.83e-05)	(3.53e-05)				
Credit (Excess)					0.0998***	-0.229***	-0.362***	-0.823***
					(0.0230)	(0.0468)	(0.0470)	(0.0939)
Credit[0]					-6.16e-05***	-0.000133***	-6.91e-05***	-0.000238***
					(6.52e-06)	(1.33e-05)	(1.29e-05)	(2.58e-05)
Constant	0.00967***	0.0211***	0.00617***	0.0213***	0.00979***	0.0214***	0.00500***	0.0156***
	(0.000652)	(0.00127)	(0.00138)	(0.00266)	(0.000425)	(0.000866)	(0.000870)	(0.00174)
Observations	1,346	1,346	389	389	1,397	1,397	385	385
R-squared	0.051	0.032	0.051	0.153	0.143	0.069	0.149	0.235
Number of country	18	18	18	18	19	19	19	19

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Country fixed effects included. "[0]" indicates the level at the beginning of each business cycle. "GDP" is GDP per capita quarterly growth. "TFP" is total factor productivity quarterly growth. We use Multifactor productivity from OECD database. We use a linear interpolation to transform annual data into quarterly data.

6. Concluding Remarks

We propose in this paper a new methodology to study the interactions between excess financial growth and economic growth. We show that the finance-growth elasticity in the long-run can be viewed as the cumulative of finance-growth interactions within each cycle through a growth channel and a duration channel. Our empirical analysis delivers two key properties of the interactions between finance and growth.

We first show that the contemporaneous elasticity between financial and economic growth rates is positive, even if high financial growth makes recessions more severe. It is in line with Jordà et al. (2013) who show that credit-intensive expansions tend to be followed by deeper recessions. It is also coherent with Loayza and Ranciere (2006) who find a positive long-run relationship between financial intermediation and output growth that co-exists with a mostly negative short-run relationship. In our paper, growth supplements result not only from higher average growth rate but also from longer duration of expansions. The identification of a link between finance and expansion duration is a new contribution to the literature. In our paper, high excess finance is accompanied by a longer duration of expansions. The duration channel accounts for one fifth of total elasticity in the case of house prices. Several mechanisms could explain this property. A first interpretation could be based on the procyclical behaviour of finance as stated by the financial accelerator mechanism developed by Bernanke et al. (1999). Indeed, an improvement of the fundamentals of the economic leads to more both growth and financial activities. A second interpretation could be based on the "time is different" syndrome developed by Reinhart and Rogoff (2008). A long expansion may be a favorable context for the development of beliefs at the origin of excessive developments of financial activities. A third interpretation could be that bubbles in the expansion phase can play as a shock absorber. An oil shock could be for example more easily absorbed in a country when growth is fed by a bubble. Further research would be needed to investigate the links between the duration of expansion and excess finance, in particular the sense of causality and economic mechanisms behind the relationship.

Beyond the contemporaneous effects of financial booms, we show that the elasticity between financial and economic growth turns out negative when the persistent effects of excess finance are taken into account. More precisely, financial and economic growth rates are positively correlated only up to a certain threshold of financial activity. As the average level of financial activity is well above this threshold, we get a negative total elasticity between finance and growth. This second property can be related to the concept of "Debt Supercycle" developed by Rogoff (2015) according to which the inheritance of excessive development of finance in the past can lead to long-lasting low economic growth. This result could also be linked to the notion of deleveraging crisis formalized by Eggertsson and Krugman (2012). Another potential explanation is based on the long-run consequences of financial booms on productivity. Evidence described in this paper seem to suggest that excess finance is positively correlated with GDP growth but negatively correlated with total factor productivity (TFP) growth. This could be explained by the mechanism described by Borio et al. (2016) according to which credit booms tend to undermine productivity growth by inducing labour reallocations towards lower productivity growth sectors. More research would be needed to investigate the hysteresis effect and the consequences of financial booms on productivity.

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Appendix

A. Tables

A. Tables: Summary Statistics and Variables definitions

Table A.1 – Summary Statistics: Financial Series

	(1) N	(2) Mean	(3) Median	(4) Min	(5) Max
House Prices(Excess)	3,074	1.19e-10	0.00115	-0.0832	0.0591
Price-Rent ratio(Excess)	2,997	-8.71e-11	0.00110	-0.0826	0.0319
Real Credit(Excess)	3,636	-4.51e-10	0.000295	-0.0297	0.0270
Credit/GDP(Excess)	3,696	-8.34e-11	9.41e-05	-0.0400	0.0227
Households Credit(Excess)	2,518	7.67e-10	-0.00159	-0.0302	0.0327
Households Credit/GDP(Excess)	2,518	-1.30e-10	-0.00111	-0.0433	0.0323

Table A.2 – Summary Statistics: Business Cycles

	(1) N	(2) Mean	(3) Median	(4) Min	(5) Max
Duration Boom	228	14.61	11	2	67
Duration Cycle	228	18.18	15	3	70
Duration Recession	228	3.566	3	1	23

Table A.3 – Variables definitions

Variables (Abbreviation)	Sources	Variable description
Total credit (Total credit)	BIS Long series on credit to the private non-financial sector	Credit to non-financial private sector (Borrowing sector: Private non-financial sector that is resident in the economy, Lending sector: All sectors), National currency , Quarterly.
Households Credit (Households Credit)	BIS Long series on credit to the private non-financial sector	Credit to non-financial private sector – Credit to Non-financial Corporations, National currency , Quarterly.
Gross domestic product (GDP)	OECD, Quarterly National Accounts	National currency, volume estimates, OECD reference year, annual levels, seasonally adjusted, Quarterly.
Population (Population)	OECD, Historical population data and projections	Population, 15-64, Persons, thousands.
GDP per capita (GDP per capita)	OECD	GDP/Population 15-64, Quarterly.
House Prices (House Prices)	International House Prices Database, Federal Reserve Bank of Dallas	Residential property prices, real terms, Quarterly
Price-to-Rent Ratio (Price-to-Rent)	OECD Housing Prices Database	Nominal House Price divided by Rent price, Quarterly
Schooling (Schooling)	Barro and Lee (2013), International Human Development Indicators	Average years of schooling of population aged 25 and over
Financial Reforms	IMF, 2008 (Abiad et al, 2008)	Financial Reform Index, normalized to be between 0 and 1.
Bank crisis (Bank crisis)	GFDD (Laeven and Valencia, 2013)	Dummy variable for the presence of banking crisis (1=banking crisis, 0=none).

B. Tables: Regression Results for other measures of Excess Finance

Table A.4 – Price/Rent

	(1) GDP growth (OLS)	(2) GDP growth (OLS)	(3) Duration (Weibull)	(4) Duration (Weibull)
Period	Expansion	Recession	Expansion	Recession
Price Rent(Excess)	0.0881***	-0.0671***	24.49***	5.184
	(0.0121)	(0.0191)	(5.276)	(4.100)
Price Rent[0]	-3.44e-05***	-6.38e-05***	-0.000266	-0.00225
	(7.68e-06)	(1.39e-05)	(0.00187)	(0.00183)
Constant	0.00773***	0.00600***		
	(0.000611)	(0.00113)		
Observations	2,200	756	160	160
Number of countries	24	24	24	24
R^2	0.040	0.037		
P (Weibull distribution para.)			1.264	1.343

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Country fixed effects included. "Excess" stands for excess financial growth. "[0]" indicates the level at the beginning of each business cycle. "GDP growth" is real GDPquarterly growth per capita. "Duration" stands for the duration (in quarters) of each phase of the business cycle.

Table A.5 – Real Credit

	(1) GDP growth (OLS)	(2) GDP growth (OLS)	(3) Duration (Weibull)	(4) Duration (Weibull)
Period	Expansion	Recession	Expansion	Recession
Credit(Excess)	0.110***	-0.143***	33.94***	9.007
	(0.0149)	(0.0268)	(7.292)	(6.348)
Credit[0]	-4.63e-05***	-4.12e-05***	-0.000930	0.000232
	(4.34e-06)	(7.54e-06)	(0.00193)	(0.00171)
Constant	0.00826***	0.00308***		
	(0.000240)	(0.000451)		
Observations	2,794	842	180	180
Number of countries	24	24	24	24
R^2	0.103	0.048		
P (Weibull distribution para.)			1.330	1.300

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Country fixed effects included. "Excess" stands for excess financial growth. "[0]" indicates the level at the beginning of each business cycle. "GDP growth" is real GDPquarterly growth per capita. "Duration" stands for the duration (in quarters) of each phase of the business cycle.

Table A.6 – Credit/GDP

	(1) GDP growth (OLS)	(2) GDP growth (OLS)	(3) Duration (Weibull)	(4) Duration (Weibull)
Period	Expansion	Recession	Expansion	Recession
Credit/GDP(Excess)	0.0340**	-0.179***	38.46***	12.70**
	(0.0162)	(0.0270)	(7.077)	(6.243)
Credit/GDP[0]	-0.00391***	-0.00282***	0.00179	0.0200
	(0.000333)	(0.000574)	(0.119)	(0.0957)
Constant	0.0105***	0.00416***		
	(0.000397)	(0.000706)		
Observations	2,828	868	186	186
Number of countries	24	24	24	24
R^2	0.062	0.058		
P (Weibull distribution para.)			1.301	1.306

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Country fixed effects included. "Excess" stands for excess financial growth. "[0]" indicates the level at the beginning of each business cycle. "GDP growth" is real GDPquarterly growth per capita. "Duration" stands for the duration (in quarters) of each phase of the business cycle.

Table A.7 – Real Households Credit

	(1) GDP growth (OLS)	(2) GDP growth (OLS)	(3) Duration (Weibull)	(4) Duration (Weibull)
Period	Expansion	Recession	Expansion	Recession
Households Credit(Excess)	0.0795***	-0.0761***	16.18**	0.119
	(0.0165)	(0.0291)	(7.849)	(6.411)
Households Credit[0]	-5.90e-05***	-2.62e-05***	-0.00621***	-0.000638
	(5.22e-06)	(8.75e-06)	(0.00228)	(0.00178)
Constant	0.00896***	0.00211***		
	(0.000287)	(0.000557)		
Observations	1,973	545	117	117
Number of countries	22	22	22	22
R^2	0.139	0.020		
P (Weibull distribution para.)			1.364	1.459

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Country fixed effects included. "Excess" stands for excess financial growth. "[0]" indicates the level at the beginning of each business cycle. "GDP growth" is real GDP quarterly growth per capita. "Duration" stands for the duration (in quarters) of each phase of the business cycle.

Table A.8 – Households Credit/GDP

	(1) GDP growth (OLS)	(2) GDP growth (OLS)	(3) Duration (Weibull)	(4) Duration (Weibull)
Period	Expansion	Recession	Expansion	Recession
Households Credit/GDP(Excess)	0.0661***	-0.0872***	34.92***	4.596
	(0.0173)	(0.0296)	(8.361)	(6.681)
Households Credit/GDP[0]	-0.0115***	-0.00345**	-0.130	0.106
	(0.000955)	(0.00156)	(0.316)	(0.239)
Constant	0.0112***	0.00224***		
	(0.000443)	(0.000787)		
Observations	1,973	545	117	117
Number of countries	22	22	22	22
R^2	0.104	0.020		
P (Weibull distribution para.)			1.325	1.460

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Country fixed effects included. "Excess" stands for excess financial growth. "[0]" indicates the level at the beginning of each business cycle. "GDP growth" is real GDP quarterly growth per capita. "Duration" stands for the duration (in quarters) of each phase of the business cycle.

C. Tables: Elasticities

Table A.9 – Direct Elasticity between Growth and Excess Finance

	(1) Growth(ex)	(2) Growth(re)	(3) Growth(tot)	(4) Dura(ex)	(5) Dura(re)	(6) Dura(tot)	(7) Total
House Prices	5.01	-1.93	3.08	0.36	0.00	0.36	3.43
Price to Rent	6.56	-1.71	4.85	0.46	0.00	0.46	5.31
Real Credit	8.20	-3.65	4.55	0.63	0.00	0.63	5.18
Credit to GDP	2.53	-4.56	-2.03	0.72	-0.24	0.48	-1.55
Real Households Credit	5.92	-1.94	3.98	0.30	0.00	0.30	4.28
Households Credit to GDP	4.92	-2.23	2.70	0.65	0.00	0.65	3.35

Notes: We measure GDP growth elasticity with respect to the various measures of excess financial growth. "Growth(ex)", "Growth(re)", "Growth(tot)" are the GDP growth channels during expansion, recession and for the whole business cycle. "Dura(ex)", "Dura(re)", "Dura(tot)" are the duration channels during expansion, recession and for the whole business cycle. "Total" is the direct elasticity.

Table A.10 – Elasticity when measuring the Persistent Effects of Excess Finance

	(1) Growth(ex)	(2) Growth(re)	(3) Growth(tot)	(4) Dura(ex)	(5) Dura(re)	(6) Dura(tot)	(7) Total
House Prices	-4.77	-1.34	-6.11	0.00	0.10	0.10	-6.01
Prices to Rent	-3.36	-2.14	-5.50	0.00	0.00	0.00	-5.50
Real Credit	-4.07	-1.24	-5.31	0.00	0.00	0.00	-5.31
Credit to GDP	-6.41	-1.58	-7.99	0.00	0.00	0.00	-7.99
Real Households Credit	-5.15	-0.78	-5.93	-0.14	0.00	-0.14	-6.07
Households Credit to GDP	-8.47	-0.87	-9.35	0.00	0.00	0.00	-9.35

Notes: We measure GDP growth elasticity with respect to the various measures of excess financial growth. "Growth(ex)", "Growth(re)", "Growth(tot)" are the GDP growth channels during expansion, recession and in the long-run measuring only the persistent effects of Excess finance. "Dura(ex)", "Dura(re)", "Dura(tot)" are the duration channels during expansion, recession and in the long-run measuring only the persistent effects of Excess finance. "Total" is the long-run elasticity measuring only the persistent effects of Excess finance.

Table A.11 – Total Elasticity between Growth and Excess Finance with Hysteresis

	(1) Growth(ex)	(2) Growth(re)	(3) Growth(tot)	(4) Dura(ex)	(5) Dura(re)	(6) Dura(tot)	(7) Total
House Prices	0.25	-3.28	-3.03	0.36	0.10	0.46	-2.58
Price to Rent	3.20	-3.85	-0.65	0.46	0.00	0.46	-0.19
Real Credit	4.12	-4.89	-0.77	0.63	0.00	0.63	-0.13
Credit to GDP	-3.87	-6.14	-10.02	0.72	-0.24	0.48	-9.54
Households Credit	0.78	-2.72	-1.95	0.17	0.00	0.17	-1.78
Households Credit to GDP	-3.55	-3.10	-6.65	0.65	0.00	0.65	-6.00

Notes: We measure GDP growth elasticity with respect to the various measures of excess financial growth. "Growth(ex)", "Growth(re)", "Growth(tot)" are the GDP growth channels during expansion, recession and in the long-run. "Dura(ex)", "Dura(re)", "Dura(tot)" are the duration channels during expansion, recession and in the long-run. "Total" is the total long-run elasticity.

Table A.12 – Threshold for the initial value of Financial series

	(1) Threshold	(2) Mean Value	(3) %
House Prices	36.07	75.85	41%
Price to Rent	58.39	82.10	71%
Real Credit	35.89	59.15	61%
Credit to GDP	.	.	.
Households Credit	29.68	65.15	46%
Households Credit to GDP	0.13	0.50	26%

Notes: All series (except Households Credit to GDP) are indices (base 100=2005). In column 1, the threshold is equal to 36% of house price value in 2005. We cannot measure a threshold for credit to GDP as in this case the direct effect is negative. Column (2) indicates the mean value of the initial level of the financial series. We divide in column (3) the value of the threshold (column (1)) by the mean value (column (2)).

D. Tables for Simulations and Figure 2

Table A.13 – Business Cycles

		$c=1$	$c=2$	$c=3$
The Mean Case	ϕ_c^{ex}	0	0	0
Panels A, B, C (black lines)	ϕ_c^0	$\overline{\phi}^0$	$\overline{\phi}^0$	$\overline{\phi}^0$
The Low Excess Finance Case	ϕ_c^{ex}	$-\mathrm{sd}\left(\phi^{ex}\right)$	$-\mathrm{sd}\left(\phi^{ex}\right)$	$-\mathrm{sd}\left(\phi^{ex}\right)$
Panels A, B, C (dotted red lines)	ϕ_c^0	$\overline{\phi}^0$	$\overline{\phi}^0$	$\overline{\phi}^0$
The High Excess Finance Case	ϕ_c^{ex}	$\mathrm{sd}\left(\phi^{ex}\right)$	$\mathrm{sd}\left(\phi^{ex}\right)$	$\mathrm{sd}\left(\phi^{ex}\right)$
Panel A (blue line)	ϕ_c^0	$\overline{\phi}^0$	$\overline{\phi}^0$	$\overline{\phi}^0$
... with persistence	ϕ_c^{ex}	$\mathrm{sd}\left(\phi^{ex}\right)$	0	0
Panel B (dashed blue line)	ϕ_c^0	$\overline{\phi}^0$	$\overline{\phi}^0 + \phi_1^{ex}\tau_1^{ex}$	ϕ_2^0
... with bubbles	ϕ_c^{ex}	$\mathrm{sd}\left(\phi^{ex}\right)$	$-\delta \times \mathrm{sd}\left(\phi^{ex}\right)$	0
Panel C (dashed blue line)	ϕ_c^0	$\overline{\phi}^0$	$\overline{\phi}^0 + \phi_1^{ex}\tau_1^{ex}$	$\phi_1^0 + \phi_2^{ex}\tau_2^{ex}$

Table A.14 – House Prices (Excess) and House Prices[0]: Descriptive Statistics for the two last complete business cycles

		Trough	Peak	Excess Finance	Finance Init.
France	Cycle 1	2003q2	2008q1	.0136761	77.23
	Cycle 2	2009q2	2013q4	-.0052328	104.61
Germany	Cycle 1	1996q1	2001q	-.0093298	115.96
	Cycle 2	2003q1	2008q1	-.0109035	105.18
Spain	Cycle 1	1993q2	2007q4	.0053897	52.86
	Cycle 2	2009q4	2011q1	-.0267497	96.22
United Kingdom	Cycle 1	1991q3	2007q4	.0056966	49.81
	Cycle 2	2009q2	2010q4	-.0017739	94.6
United States	Cycle 1	1991q2	2000q4	-.0025686	64.28
	Cycle 2	2002q1	2007q4	.0022039	81.79

Notes: We use house prices as a measure for Excess Finance and "Finance Init" (the level of House Prices at the beginning of each business cycle). We consider only the two last and complete business cycles in each country.

B. Identification Strategy

To explain the identification strategy, we follow the exposition of Lewbel (2012) and its application in the finance-growth literature by Arcand et al. (2015). Let Y_1 and Y_2 be observed endogenous variables, with Y_1 the GDP growth and Y_2 the excess finance, X a vector of explanatory variables, and $\varepsilon = (\varepsilon_1, \varepsilon_2)$ unobserved errors. The standard growth regression is specified as follows

$$Y_1 = \beta_1 X + \gamma_1 Y_2 + \varepsilon_1 \tag{B.1}$$

where an endogeneity issue arises because of reverse causation from growth to excess finance according to

$$Y_2 = \beta_2 X + \gamma_2 Y_1 + \varepsilon_2 \tag{B.2}$$

The exogenous regressors X should satisfy here the minimal assumption that $E(\varepsilon X) = 0$. Lewbel (2012) demonstrated that the structural model parameters, namely the β, remain unidentified under the standard homoskedasticity assumption that $E(\varepsilon\varepsilon'|X)$ is constant. However, the structural model parameters may be identified given some heteroskedasticity, in particular if $\operatorname{cov}\left(X, \varepsilon_j^2\right) \neq 0$, for $j = 1, 2$, and $\operatorname{cov}(Z, \varepsilon_1\varepsilon_2) \neq 0$ for an observed Z, where Z can be a subset of X. Arcand et al. (2015) suggest to use $X\varepsilon_2$ as an instrument for Y_2. This is a good instrument because the assumption that $cov(X, \varepsilon_1\varepsilon_2) = 0$ guarantees that $X\varepsilon_2$ is uncorrelated with ε_1, and the presence of heteroskedasticity ($cov(X, \varepsilon_2^2) \neq 0$) guarantees that $X\varepsilon_2$ is correlated with ε_2 and thus with Y_2. Using the stata function ivreg2h.do, we use the instrument $(Z - \mathrm{E}(Z))\,\varepsilon_2$ as originally suggested by Lewbel (2012).

C. Details for the Computation of Elasticities

Let us first define the elasticity of relative duration w.r.t. to excess finance. The first order partial derivative of $\pi_{i,c}^{ex}$ w.r.t. to $\phi_{i,c}^{ex}$ is

$$\frac{\partial \pi_{i,c}^{ex}}{\partial \phi_{i,c}^{ex}} = \frac{\partial}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{ex}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \right) \tag{C.3}$$

then,

$$\frac{\partial \pi_{i,c}^{ex}}{\partial \phi_{i,c}^{ex}} = \frac{\partial \tau_{i,c}^{ex}}{\partial \phi_{i,c}^{ex}} \frac{1}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \pi_{i,c}^{re} - \frac{\partial \tau_{i,c}^{re}}{\partial \phi^{ex}} \frac{1}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \pi_{i,c}^{ex} \tag{C.4}$$

The first order partial derivative of $\pi_{i,c}^{re}$ w.r.t. to ϕ^{ex} is

$$\frac{\partial \pi_{i,c}^{re}}{\partial \phi_{i,c}^{ex}} = \frac{\partial}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{re}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \right) \tag{C.5}$$

then,

$$\frac{\partial \pi_{i,c}^{re}}{\partial \phi_{i,c}^{ex}} = \frac{\partial \tau_{i,c}^{re}}{\partial \phi_{i,c}^{ex}} \frac{1}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \pi_{i,c}^{ex} - \frac{\partial \tau_{i,c}^{ex}}{\partial \phi_{i,c}^{ex}} \frac{1}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \pi_{i,c}^{re} \tag{C.6}$$

The following partial derivatives are useful to get the expressions of elasticities provided in the paper

$$\frac{\partial}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{ex}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} g_{i,c}^{ex} \right) = \frac{\partial}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{ex}}{\mathcal{T}_{i,c}^{ex} + \tau_{i,c}^{re}} \right) \times g_{i,c}^{ex} + \frac{\partial g_{i,c}^{ex}}{\partial \phi_{i,c}^{ex}} \times \left(\frac{\tau_{i,c}^{ex}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \right) \tag{C.7}$$

where $\frac{\partial}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{ex}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \right)$ is given by (C.4), then (C.7) becomes

$$\begin{aligned} \frac{\partial}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{ex}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} g_{i,c}^{ex} \right) &= \frac{\partial \tau_{i,c}^{ex}}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{re}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \frac{g_{i,c}^{ex}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \right) \\ &\quad - \frac{\partial \tau_{i,c}^{re}}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{ex}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \frac{g_{i,c}^{ex}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \right) + \frac{\partial g_{i,c}^{ex}}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{ex}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \right) \end{aligned} \tag{C.8}$$

Similarly,

$$\frac{\partial}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{re}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} g_{i,c}^{re} \right) = \frac{\partial}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{re}}{\mathcal{T}_{i,c}^{ex} + \tau_{i,c}^{re}} \right) \times g_{i,c}^{re} + \left(\frac{\tau_{i,c}^{ex}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \right) \times \frac{\partial g_{i,c}^{re}}{\partial \phi_{i,c}^{ex}} \tag{C.9}$$

where $\frac{\partial}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{re}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \right)$ is given by (C.6), then (C.9) becomes

$$\begin{aligned} \frac{\partial}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{re}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} g_{i,c}^{re} \right) &= \frac{\partial \tau_{i,c}^{re}}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{ex}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \frac{g_{i,c}^{re}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \right) \\ &\quad - \frac{\partial \tau_{i,c}^{ex}}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{re}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \frac{g_{i,c}^{re}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \right) + \frac{\partial g_{i,c}^{re}}{\partial \phi_{i,c}^{ex}} \left(\frac{\tau_{i,c}^{ex}}{\tau_{i,c}^{ex} + \tau_{i,c}^{re}} \right) \end{aligned} \tag{C.10}$$

The sum of (C.8) and (C.10) is

$$\begin{aligned} & \frac{\partial}{\partial \phi^{ex}_{i,c}} \left(\frac{\tau^{ex}_{i,c}}{\tau^{ex}_{i,c} + \tau^{re}_{i,c}} g^{ex}_{i,c} \right) + \frac{\partial}{\partial \phi^{ex}_{i,c}} \left(\frac{\tau^{ex}_{i,c}}{\mathcal{T}^{ex}_{i,c} + \tau^{re}_{i,c}} g^{ex}_{i,c} \right) \\ = \; & \frac{\partial g^{ex}_{i,c}}{\partial \phi^{ex}_{i,c}} \left(\frac{\tau^{ex}_{i,c}}{\tau^{ex}_{i,c} + \tau^{re}_{i,c}} \right) + \frac{\partial g^{re}_{i,c}}{\partial \phi^{ex}_{i,c}} \left(\frac{\tau^{ex}_{i,c}}{\tau^{ex}_{i,c} + \tau^{re}_{i,c}} \right) + \left(\frac{\partial \tau^{ex}_{i,c}}{\partial \phi^{ex}_{i,c}} \tau^{re}_{i,c} - \frac{\partial \tau^{re}_{i,c}}{\partial \phi^{ex}_{i,c}} \tau^{ex}_{i,c} \right) \frac{g^{ex}_{i,c} - g^{re}_{i,c}}{\left(\tau^{ex}_{i,c} + \tau^{re}_{i,c} \right)^2} \end{aligned} \tag{C.11}$$

that is the term in the sum defined by equation (7). Using (9) and (11), (C.11) becomes

$$\begin{aligned} & \frac{\partial}{\partial \phi^{ex}_{i,c}} \left(\frac{\tau^{ex}_{i,c}}{\tau^{ex}_{i,c} + \tau^{re}_{i,c}} g^{ex}_{i,c} \right) + \frac{\partial}{\partial \phi^{ex}_{i,c}} \left(\frac{\tau^{ex}_{i,c}}{\mathcal{T}^{ex}_{i,c} + \tau^{re}_{i,c}} g^{ex}_{i,c} \right) \\ = \; & \alpha^{ex}_{g} \left(\frac{\tau^{ex}_{i,c}}{\tau^{ex}_{i,c} + \tau^{re}_{i,c}} \right) + \alpha^{re}_{g} \left(\frac{\tau^{ex}_{i,c}}{\tau^{ex}_{i,c} + \tau^{re}_{i,c}} \right) + \left(\alpha^{ex}_{\tau} - \alpha^{re}_{\tau} \right) \frac{\tau^{ex}_{i,c} \tau^{re}_{i,c}}{\left(\tau^{ex}_{i,c} + \tau^{re}_{i,c} \right)^2} \left(g^{ex}_{i,c} - g^{re}_{i,c} \right) \end{aligned} \tag{C.12}$$

which is considered in equation (12).

The (semi-)elasticity of the initial value of the financial series with respect to the past value of excess finance defined by equation (16) is

$$\begin{aligned} \frac{\partial \phi^0}{\partial \phi^{ex}_{-1}} \; & \equiv \; \frac{1}{n} \sum_{i=1}^{n} \frac{1}{C_i} \sum_{c=1}^{C^i} \frac{\partial \phi^0_{i,c+1}}{\partial \phi^{ex}_{i,c}} \\ & = \; \left(1 + \alpha^{ex}_{\tau} \bar{\phi}^{ex} \right) \frac{1}{n} \sum_{i=1}^{n} \frac{1}{C_i} \sum_{c=1}^{C^i} \phi^0_{i,c} \tau^{ex}_{i,c} + \left(\alpha^{re}_{\phi} + \alpha^{re}_{\tau} \overline{\phi}^{re} \right) \frac{1}{n} \sum_{i=1}^{n} \frac{1}{C_i} \sum_{c=1}^{C^i} \phi^0_{i,c} \tau^{re}_{i,c} \\ & \quad + \alpha^{ex}_{\tau} \frac{1}{n} \sum_{i=1}^{n} \frac{1}{C_i} \sum_{c=1}^{C^i} \phi^0_{i,c} \tau^{ex}_{i,c} \phi^{ex}_{i,c} + \alpha^{re}_{\tau} \frac{1}{n} \sum_{i=1}^{n} \frac{1}{C_i} \sum_{c=1}^{C^i} \phi^0_{i,c} \phi^{re}_{i,c} \tau^{re}_{i,c} \end{aligned} \tag{C.13}$$

using the equations (11) and (14) where the coefficient α^{re}_{ϕ} is the outcome of the following regression:

$$\phi^{re}_{i,c} = c^{re}_{\phi} + f^{re}_{i} + \alpha^{re}_{\phi} \phi^{ex}_{i,c} + \varepsilon_{i,c}. \tag{C.14}$$