Firms' Marginal Propensities to Invest

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Abstract

How to stimulate aggregate investment? There are different transmission channels from macroeconomic policies to firm's investment. Changes in firms' income is an important one. Therefore, designing efficient counter-cyclical policies requires an understanding of how changes in firms' income translate into changes in firms' investment and which firms are the most responsive to such policies. In this paper, I use a new method to estimate firms' marginal propensities (MPIs) to invest out of a transitory liquid income shock. I use a semi-structural method developed in the household literature and I show that this method can overcome difficulties encountered in previous estimations. I also investigate MPIs heterogeneity across firms. I show that firms' MPIs are positive and significantly different from 0. On average, firms use 14.4% of the change in current income caused by a transitory income shock to invest. Moreover, firms that face financial constraints and/or firms that face liquidity constraints have higher MPIs than the ones that don't. Finally, I show that MPIs are very heterogeneous across sectors.

Keywords : Heterogeneous firms, monetary policy, investment.

JEL Classification : D21, D22, E61, E62

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1 Introduction

Managing the business cycle requires an understanding of how public policies affect the different components of GDP. The recent interest in firms' macroeconomy has put aggregate investment at the heart of this analysis. Indeed, this aggregate accounts for a large part of GDP and is very volatile. Fiscal policy and monetary policy have an impact on firms' investment through different channels. One of those many channels is their impact on firms' income. If it is intuitive that fiscal policy has a direct effect on firms' income, this channel has been less studied in the case of monetary policy.

Different channels of transmission of monetary policy to firm investment have been identified in the literature. First, monetary policy has direct effects that go through changes in the interest rate. This channel plays through a credit channel that operates by affecting firms' new loans (Bernanke and Blinder (1988)) and a floating rate channel that operates by affecting firms balance sheet through its effect on existing loans (Ippolito et al. (2018))). Second, monetary policy has different indirect, general equilibrium effects on firms. The first general equilibrium effect goes through the effect of monetary policy on inflation, which affects the user cost of capital (Cohen et al. (1997)) and on asset prices, which has an impact on equity prices (Tobin (1969)) and collateral (Chaney et al. (2012)). The second general equilibrium effect goes through the effect of monetary policy on firms' balance sheet. Indeed, inflation affects the real value of nominal assets and debt through a Fisher effect. Moreover changes in real returns generate a wealth effect due to unhedged interest rate exposure (Auclert (2019)). Finally, it has an effect on firm income through the change in aggregate demand (Durante et al. (2020)). Some of these channels operate through the effect of monetary policy on firms' income. For instance, a decrease in the nominal interest rate decreases the interest rate that firms have to pay on their existing debt which impacts their income. The aggregate demand effects of monetary policy also impact firms' cash flow by affecting firms' sale or real wages.

Moreover, we know that changes in firm income could be an important factor of change in firm investment. For instance, we know from Khan and Thomas (2013) that firms that face constraints on their level of investment increase it when they receive a cash windfall. Jeenas (2020) also shows that a costly access to external finance is sufficient for firms to have a high propensity to investment out of a cash windfall.

In this paper, I propose to use a new approach to estimate the response of firms' investment to transitory income shock and to derive their marginal propensity to invest (MPIs). More precisely, I adapt and apply to firms a semi-structural approach used in the consumption literature. This method has been developed to estimate the households' marginal propensity to consume out of a transitory income shock. The literature begins with the pioneering paper by Blundell et al. (2008) in which the authors derive restrictions from the theory to separately identify households elasticity of consumption to a transitory and to a permanent shock. This method has been popularized by Kaplan et al. (2014) and Auclert (2019) and used in numerous papers, as in Berger et al. (2018) and Cho et al. (2021). Importantly, this method has been improved in a recent paper by Commault (2021).

Different strands of the literature study the transmission of firms' liquid income shock to their level of investment. The first one is a long tradition of corporate finance literature that tries to determine if it is possible to identify the firms that face financial constraints by studying their investment sensitivity to cash flows. The work of Fazzari et al. (1988) has started a renewed interest in this topic, followed by a flourishing and polemic literature, such as Hubbard (1998), Kaplan and Zingales (2000) and Gomes (2001)[1]. Indeed, this literature's results accuracy is highly affected by suspicions of endogeneity. Cash flow may be correlated to investment opportunities making the regression spurious. The second one uses natural experiments to estimate MPIs. Papers in this literature use observed exogenous income variations and estimate their impact of firms' investment. Say differently, they make use of cross-sectional variation to study the impact of exogenous shocks to internal funds on firms' investment. For instance, Blanchard et al. (1994) use cash windfalls in the form of a won or settled lawsuit while Lamont (1997) uses the decrease in oil firms' cash-flow following the 1986 oil price decreases. Another important source of exogenous income variations is the effect of tax reforms. Cummins et al. (1994), Goolsbee (1998), House and Shapiro (2008), Yagan (2015) and Zwick and Mahon (2017) use such reforms to identify exogenous income shock. In a similar vein, Rauh (2006) and Sasaki (2015) use direct shock to firm's internal finance as the form of shock on mandatory pension contributions. Finally, Hebous and Zimmermann (2021)

[1]See Mulier et al. (2016) for an extensive review of this literature.

uses unanticipated federal spending shocks.

Those two different strands of literature provide different estimations of firms' MPIs and a consensus has not been reached on their value. The method I use overcomes different limitations encountered in those previous estimations. First, by making a distinction between transitory and permanent income shocks my estimation is able to surpass endogeneity problems faced in the corporate finance literature. Moreover, in contrast to the literature that uses natural experiments, my paper allows to estimate MPIs over long period and not to be restricted to a rare and very specific episode of income variations. In addition, most papers using natural experiments study permanent income shocks and not transitory income shocks.

The emergence of rich datasets of firm micro data has generated a new interest in firm heterogeneity. Indeed, different papers have shown that firms are not identical in their response to shocks and that they participate differently to aggregate investment fluctuations depending on some of their characteristics (Ottonello and Winberry (2018), Jeenas (2020) for instance). This literature makes clear that the firm distribution is an important object to consider trying to understand the business cycle. It is therefore also an important object to consider trying to design more efficient countercyclical public policies. Thus, in this paper, I test different outcome of the theoretical literature to determine if I can retrieve empirical evidence of those results.

First, I investigate if firms that face financial constraints have higher MPIs. Indeed, an emerging literature shows that firms financial constraints are key to understand the heterogeneous response of firm to macroeconomic policies. For instance, firms that face such constraints react more strongly to change in monetary policy. Ottonello and Winberry (2018) shows that investment of firms with low leverage or high credit ratings react more to monetary policy shocks, Jeenas (2020) shows that firms with high level of liquid assets react comparatively less to monetary policy shocks. Cloyne et al. (2018) shows that the best proxy to identity firms that faces financial constraints is their age and that young firm's investment is indeed more responsive to monetary policy. This result is coherent with the result of the literature on fiscal policy. Zwick and Mahon (2017) shows that the investment of small firms react more to fiscal policy, Rauh (2006) shows that firms with poor credit rating also react in a stronger way. Second, I study the firms MPIs depending on their wealth liquidity. Indeed Jeenas (2020) built a model where financial frictions generate "wealthy hand-to-mouth" firms. They are firms that are not constraints on their level of investment but that have non-liquid wealth. He shows in a theoretical model that they have high marginal propensities to invest out of liquid income shock. Finally, I investigate the heterogeneity of firms MPIs depending on their sector. Indeed, we know that it is an important characteristic to understand the effect of policies on firms. For instance, Durante et al. (2020) shows that monetary policy has heterogeneous effects on firms depending on their sector.

My first key finding is that firms MPIs are significantly different from 0. Firms use about 14% of the change in current income caused by a transitory income shock to invest. Then, policies that generate income variation shocks are able to generate investment variations. I also show that the magnitude of those MPIs depends on firms' characteristics. First, I show that firms that face financial constraints have higher MPIs than the others, proxying financial constraints with age following Cloyne et al. (2018). Second, I show that firms that have low liquid wealth have higher MPIs than the other ones, what confirms Jeenas hypothesis. I also show that I can uncover the existence of the Jeenas "wealthy hand to mouth" firms, and that low liquid but non-financially constraint firms have high MPIs. Finally, I show that a small number of sectors drive the average estimation of the MPI.

This paper is structured as the following. In the first part of this paper I show that the semi-structural estimation method is well suited for the identification of firms MPIs. Then, I implement the Commault (2021) robust version of the initial Blundell et al. (2008) estimator in data from Compustat between 1970 and 2019. Finally, I apply this estimator to different subsamples of firms to identify MPIs heterogeneity among the firms.

2 Model and estimator

General Presentation of the Method The methodology developed by Blundell et al. (2008) (BPP thereafter) was initially designed to estimate households marginal propensity to consume (MPC) out of a transitory income shock. The general idea is that, if one assumes an income process and a consumption function, one can use restrictions from the theory to derive the MPC out of a transitory income shock using the joint cross-sectional distribution of consumption changes and income changes. I show here that this method can be applied to derive firms' marginal propensities to invest using firms' income and capital changes.

The BPP solution allows distinguishing between a transitory shock and a permanent shock. To do that, the key is to assume that income is a transitory-permanent process. Then, one can use future log-income growth as an instrument to identify the effect of current log-income growth on current log-consumption. Indeed, if income is a transitory-permanent process, future log-income growth captures the mean-reversion from the current transitory shock, but it is not affected by the realization of the current permanent shock. Commault (2021) has extended this method. She uses only value of future log-income growth that correlates with the current transitory shock but, no longer with any past transitory shocks. Indeed, in contrast to the initial BPP estimator, she assumes that past shocks may have an effect on current log-consumption growth. Then, she determines the value of future log-income growth that correlates with the current transitory shock but not with past transitory shocks. Finally, she uses this value of future log-income growth to instrument the current log-income growth.

Log-revenue growth The first step of this method requires determining a firm income process.

Following Guiso et al. (2005) and Juhn et al. (2018), I model the log-income of a firm i at period t as a transitory-permanent process.

$$\log \tilde{y}_{it} = \gamma_t z_{it} + p_{i,t} + \mu_{i,t}$$

The log of income $\tilde{y}_{it}$ is the sum of a permanent component $p_{i,t}$ that follows a random walk, of a transitory component $\mu_{i,t}$ that follows an $MA(k)$ process and $\gamma_t z_{i,t}$ that captures the deterministic influence of firm characteristics (to control for non-idiosyncratic shocks). Then, I can write the permanent component and the transitory component of the log-income as the following :

$$p_{i,t} = p_{i,t-1} + \eta_{i,t}$$
$$\mu_{i,t} = \varepsilon_{i,t} + \theta_1 \varepsilon_{i,t-1} + \cdots + \theta_k \varepsilon_{i,t-k}$$

With $\eta_{i,t}$ is the innovation to the permanent component and $\varepsilon_{i,t}$ the innovation to the transitory component. Indeed, we can see that $\eta_{i,t}$ affects the log-revenue at each period following the shock when $\varepsilon_{i,t}$ fades over time and it only affects it for $k+1$ period. This method also allows introducing measurement error in the measurement of the log-revenue. Then, it can be modeled as :

$$\log \tilde{y}_{it} = \gamma_t z_{it} + p_{i,t} + \mu_{i,t} + \xi^y_{i,t}$$

with $\xi_{i,t}$ a shock which captures measurement errors.

Depending on the measure of income used, the permanent component can be, for instance, persistent demand changes or, the introduction of a new technology. Thus, different types of investment fall in this category. The transitory component can be thought of as a temporary change in demand (for instance, because of temporary government command), machine breakdowns, one-time government transfers of funds, administrative closures, etc.

After detrending log-income from the effect of firms characteristics, the log of income $y_{i,t}$, net of firms characteristics, can be written as :

$$\log y_{i,t} = p_{i,t} + \mu_{i,t} + \xi^y_{i,t}$$

Then, first-differencing this detrended log-income, the growth of detrended log-income can be written as :

$$\Delta \log y_{i,t} = \eta_{i,t} + \varepsilon_{i,t} - (1-\theta_1)\varepsilon_{i,t-1} - \cdots - \theta_k \varepsilon_{i,t-k-1} + \xi^y_{i,t} - \xi^y_{i,t-1}$$

Investment growth The second step implies determining an investment function. Let's show that, the growth in detrended log-capital of firms i at period t, denoted $\log(k_{j,t+1})$, is a flexible function of the current and past realizations of the transitory and permanent shocks.

The Investment Rule in a Simple Model : Consider an economy in which, in each period, firms maximize their value, that is the expected discounted value of dividends D_t returned to their shareholders at each period. In this economy, firms are owned by the representative household and they cannot extract equity from their shareholders. They have the household's pricing kernel M_t. The only good in this economy is produced by heterogeneous firms. Capital must be installed one period before production. A firm j is endowed with production technology that transforms, at date t, capital k_t^j and labor l_t^j into y_t^j output units of the single good. β is the discount factor, δ the coefficient of depreciation and w_t is the wage at time t. Firms face an idiosyncratic technological shock $x_{j,t}$ that can be decomposed in a permanent and a transitory shock $x_{j,t} = p_{j,t} + \mu_{j,t}$ such that :

$$y_{j,t} = e^{p_{j,t}} e^{\mu_{j,t}} k_{j,t}^{\alpha} l_{j,t}^{\nu}.$$

The program of the firm j in a firm group is then :

$$\max_{(k_{t+1}^j)_{t=0}^{\infty}} \mathbb{E}_0 \left(\sum_{t=0}^{\infty} \beta^t \frac{M_t}{M_0} \left[e^{p_{j,t}} e^{\mu_{j,t}} k_{j,t}^{\alpha} l_{j,t}^{\nu} + (1-\delta) k_t^j - k_{t+1}^j - w_t l_{j,t} \right] \right)$$

$$\text{S.t} \quad D_t^j = e^{p_{j,t}} e^{\mu_{j,t}} k_{jt}^{\alpha} l_{j,t}^{\nu} + (1-\delta) k_t^j - k_{t+1}^j - w_t l_{j,t} \geq 0$$

If a firm is not constrained in its investment level, the firm's optimal investment is given by the first-order condition :

$$M_t = \beta M_{t+1} \, \mathbb{E}_t \left[\alpha e^{p_{j,t+1}} e^{\mu_{j,t+1}} (k_{t+1}^j)^{\alpha-1} l_{t+1}^j + (1-\delta) \right]$$

Thus, the investment rule depends on the expectation of the shock, which depends on the realization of the current shock. Therefore, in such models, the investment rule can be written as a function of the permanent and transitory shock $k_{j,t+1} = G_t(e^{p_{j,t}}, e^{\mu_{j,t}})$.

If the firm is constrained in its level of investment, the firm's optimal investment is given by the following condition :

$$k^j_{jt+1} = e^{p_{j,t}} e^{\mu_{j,t}} (k^j_t)^\alpha (l^j_t)^\nu + (1-\delta) k^j_t$$

If the firm is constrained, I can speficy its level of capital as a function of its previous level of asset and previous shocks $k_{jt} = H(K_{j,t-1}, e^{p_{j,t-1}}, e^{\mu_{j,t-1}})$. Iterating backward, I can write that, in any cases, $k_{j,t+1} = G_t(e^{p_{j,t}}, e^{\mu_{j,t}}, e^{p_{j,t-1}}, e^{\mu_{j,t-1}}, ...)$.

Finally,

$$\Delta \log(k_{j,t+1}) = g_t(\eta_{j,t}, \ldots, \eta_{j,1}, \varepsilon_{j,t}, \ldots, \varepsilon_{j,1})$$

Therefore, the log-capital of firms j at period t, detrended, is a flexible function of the current and past realizations of the transitory and permanent shocks.

I add to this specification error measurement shocks, and rewrite the detrended log-capital of firms j at period t as :

$$\Delta \log(k_{j,t+1}) = g_t(\eta_{j,t}, \ldots, \eta_{j,1}, \varepsilon_{j,t}, \ldots, \varepsilon_{j,1}, \xi^k_{j,t} \ldots \xi^k_{j,t-1})$$

Those shocks capture measurement error or an investment-specific shifter.

Precision on the investment rule If shocks on firms income have an impact on the expected return of capital, I can always write the capital of firms j at period t as a function of the current and past realizations of those shocks. For instance, if the shock has an effect on productivity, wages, or demand. If the shock is not related to the expected return on capital, some frictions are necessary for this relationship to exist. For instance, Jeenas (2020) showed that frictions on the cost of external finance was enough to generate this pattern, even if a firm is not financially constrained. Indeed, firms use their internal fund to invest to avoid paying a cost on external funding. Then, they are constrained in their level of investment by their internal finance. A shock on their income, even if it is not related to the expected marginal return of capital, relaxes this constraint and affects their level of capital investment.

Distributional assumptions I make some standard assumptions about the distribution of the shocks. I assume that :

1. the shocks ε, η are drawn independently from one another,
2. they are drawn independently over time,
3. they are drawn independently across firms.

I also assume firm characteristics are independent of firm shocks.

Pass-through coefficient The coefficient that I want to estimate using this method is denoted ϕ_ε. It is the ratio of the covariance between log-capital growth and the contemporaneous transitory shock over the variance of the shock. I can rewrite it as the covariance between the log-capital decision and the contemporaneous transitory shock, over the variance of the shock because the past log-capital decision $\log(k_{i,t})$ does not depend on the value of the realization of the transitory shock at t. Following the interpretation of Kaplan and Violante (2010), it is also the share of the variance of the transitory shocks that is passed on to log-capital decision.

$$\phi^\varepsilon = \frac{cov(\Delta \log(k_{j,t+1}), \varepsilon_{j,t})}{var(\varepsilon_{j,t})} = \frac{cov(\log(k_{j,t+1}), \varepsilon_{j,t})}{var(\varepsilon_{j,t})}$$

Under given assumptions (for instance that the transitory shocks are normally distributed or that log-capital growth is linear in the current transitory shock), this coefficient is also the average elasticity of capital decision to a transitory shock.

$$\phi^\varepsilon = \frac{cov(\Delta \log(k_{j,t}), \varepsilon_{j,t})}{var(\varepsilon_{j,t})} = \mathbb{E}\left[\frac{d\log(k_{j,t})}{d\varepsilon_{i,t}}\right]$$

2.1 Identification

Contrary to the natural experiment literature, when using survey data, the realization of the transitory shock is not directly observable. I only have access to the total income, that can be the result of the realisation of different shocks : the current transitory shock, the current permanent shock, and the past transitory shocks.

I use the robust estimator of Commault (2021) to estimate the effect of the current transitory shock in current log-income growth, independently of the effect of the current permanent shock in current log-income growth. The key of this method is to instrument the current log-income growth with the future log-income growth at time $t+k+1$. The future log-income growth at this precise date is correlated with the transitory shock at time t ; but not with the other shocks, past or present that have an effect of log-capital growth. Then I use the following estimator of the pass-through coefficient :

$$\hat{\phi}_\varepsilon = \frac{cov(\Delta \log(k_{j,t}) - \Delta \log(y_{j,t+k+1}))}{cov(\Delta \log(y_{j,t}) - \Delta \log(y_{j,t+k+1}))}$$

Endogeneity One of the main advantages of this method is that it allows disentangling between transitory and permanent income shocks. Taking separately permanent and transitory income shocks allows ripping out the main endogeneity problem. Indeed, I study here the effect of income variation on investment and it seems plausible that my estimation could be concerned by reverse causality, i.e. the correlation is in fact going from variation in investment to variation in firms' income. Put differently, I could capture supply shocks and not demand shocks. However, variation in investment generates only permanent income shocks. Investment has a permanent effect on firms' income. Then, considering only the transitory component of income variation, I identify solely the effect of income variation on investment.

Marginal Propensity to Invest To derive the marginal propensity to invest out of a transitory shock from this pass-through coefficient, I use the following relation :

$$MPI_{i,t}^{\varepsilon} = \frac{\partial k_{i,t}/\partial \varepsilon_{i,t}}{\partial y_{i,t}/\varepsilon_{i,t}} = \frac{k_{i,t}}{y_{i,t}} \frac{\partial \log(k_{i,t})}{\partial \varepsilon_{i,t}}$$

The pass-through coefficient is a proxy of the average elasticity $\mathbb{E}\, \frac{\partial \log(k_{i,t})}{\partial \varepsilon_{i,t}}$, then, if the elasticity is the same across firms, I can approximate the average elasticity with the individual ones. As shown by Commault (2021), if the firms that are the most responsive are also on average the ones with the highest ratios of capital investment over income, this approximation is a lower bound for the true average MPI.

$$\underline{\text{MPI}}^{\varepsilon} = \mathbb{E}\left[\frac{k_{i,t}}{y_{i,t}}\right] \phi^{\varepsilon}$$

I show in appendix A.3.1 that it is indeed the case.

3 Results

3.1 Data

My main source of data to estimate the pass-trough coefficient is Compustat, a yearly panel of publicly listed U.S. firms. I follow standard practice in the investment literature to build my database. I consider the period from 1970 to 2019. To deflate variables I use Consumer Price Index (CPI) data from the Bureau of Economic Analysis (BEA). The sample selection and the definition of the variables are detailed in appendix A.1 .

My main measure of investment is $\Delta k_{j,t+1}$, with $k_{j,t+1}$ a measure of the end of period t of the firms j stock of capital. My main measure of firm income is firm revenue. Revenue is the total amount of income generated by the sale of goods or services. Then, I use real sales here. Table 1 displays the main summary statistics of the sample used in my estimation. I show in appendix A.2.3 that this result holds with different measure of income such that value-added.

Table 1: Summary statistics

Variable	Mean	Std. Dev.	N
Δlog(capital)	0.08	0.36	100,909.00
Δlog(real sale)	0.06	0.37	149,795.00

Detrending from past demographic characteristics Following Commault (2021), I detrend my two main variables, log-revenue and log-capital from the impact of firms characteristics and past firm characteristics. In this vector of control, I include variables that control for strictly exogenous firm characteristics (firm age, sectors, states) and other important firms characteristics (accounting, for their endogeneity) such that the (lag) firm leverage ratio, the (lag) size of the firm and its (lag) Tobin's Q. I also add year fixed effect. I regress log-revenue and log-capital on those variables. I interact the variables with year dummies so their effect can change over years. I present different ways to detrend variables in the appendix A.2.2 and show that my results are robust to different specifications.

3.1.1 Estimating moments

The first line of Table 2 presents the autocovariance of detrended log-revenue growth. It suggests that the transitory component of revenue is a MA(2). Indeed, the autocovariance is statistically significant up to $t+3$ and stop being significantly different from 0 afterwards. Moreover, the fact that the autocovariance between t and period after $t+3$ stop being significantly different from 0 discards the hypothesis of the permanent income being an AR(1) with a coefficient different from one. In Appendix A.2.1, I show that my results are robust when I use a MA(1) instead. I also show in Appendix A.3.2 that my results are robust when I allow the permanent income to be an AR(1).

Table 2: Covariances of log-sale growth

	$\Delta\log(y_{i,t})$	$\Delta\log(y_{i,t+1})$	$\Delta\log(y_{i,t+2})$	$\Delta\log(y_{i,t+3})$	$\Delta\log(y_{i,t+4})$
$cov(\Delta\log(y_{i,t},.)$	0.158***	-0.0131***	-0.0110***	-0.00429***	-0.00109
	(36.36)	(-8.15)	(-6.70)	(-2.59)	(-0.42)
N	31479	31479	31479	24833	19768

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3 presents the covariances between detrended investment and current and future detrended log-income growth. First, we can see that the covariance between investment and contemporaneous log-income growth is significant and positive. That indicates that the variation in firm's revenue is correlated to the investment variation. Second, the covariance between detrended investment at time t and the future detrended log-income growth at time $t+3$ is negative with a point estimate of -0.004 and statistically different from 0 at 1%.

3.2 Elasticity of investment to a transitory shock

I present here the robust estimator of the pass-through coefficient of transitory shocks to investment. The point estimate is 0.56 and significantly different from 0 at 5 %.

Table 3: Covariances of log-capital growth

	$\Delta\log(y_{i,t})$	$\Delta\log(y_{i,t+1})$	$\Delta\log(y_{i,t+2})$	$\Delta\log(y_{i,t+3})$	$\Delta\log(y_{i,t+4})$
$cov(\Delta\log(k_{i,t+1},.)$	0.070***	-0.0130***	-0.00808***	-0.00248**	-0.00117
	(30.15)	(-10.70)	(-6.31)	(-1.99)	(-1.05)
N	31479	31479	31479	24833	19768

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Pass-through of transitory shocks to investment

	average
ϕ^{ε}	0.560**
	(2.05)
MPI	0.144**
N	27244

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

When the assumptions discussed previously are fulfilled, this coefficient is the average elasticity. Thus, on average, in my sample, a transitory shock that raises current real sales by 10% is associated with a 5.6% increase in capital. The average ratio of capital over sales is about one-quarter, then, the lower bound for the average MPI is about one-quarter of the average pass-through coefficient. It means that firms use about 14% of the change in current sales caused by a transitory income shock to invest.

Comparison with the literature In the literature, the estimation of firms' marginal propensity to invest out of transitory income shocks depends on the type of estimation. The standard sensitivity of investment to cash flow literature finds a coefficient that is around 0.10/0.15 in average, but varies a lot depending on the firms considered. Natural experiment find very different magnitudes depending on the shock studied. Rauh (2006) exploited a natural experiment that takes the form of an asymmetry in the funding rules for US firms. He showed that firms respond to a decrease in internal resources by reducing their investment by 60 cents per dollar of mandatory contributions. But the shocks use are likely to be permanent and not transitory. Sasaki (2015) studied similar experience but with anticipated shocks and he finds that a 1$ increase in pension deficits implies a 0.053$ decrease in capital expenditures. Zwick and Mahon (2017) studied two episodes of bonus depreciation and find a relative investment response of 10.4% between 2001 and 2004 and 16.9% between 2008 and 2010. House and Shapiro (2008) used similar natural experiment and showed that the investment supply elasticity is between 10% and 14%. The paper I am closest to is Hebous and Zimmermann (2021), whose natural experiment design ensures that the shock they use is exogenous. Moreover, the nature of this shock makes it purely transitory. They find an average response of capital investment between 10 and 15 cents per dollar after a government demand shock. My estimation of 14% is then consistent with this literature.

4 Heterogeneity

I investigate the heterogeneity of the firms' responses to a transitory income shock. I test different results from the theoretical literature. For instance, Khan and Thomas (2013) and Jeenas (2020) have shown that firms respond differently to income shock depending on some of their characteristics. I divide my firms sample in different subgroups and I run the estimator across the different samples.

4.1 Financial constraint

First, I divide my sample into firms that face financial constraints and those that do not. The most convincing proxy to identify such firms is presented in Cloyne et al. (2018). They show that firms age is the best proxy to identify firms with financial constraints. Then, I split my sample according to the age of the firms. I create two categories, young firms, that are less than 15 years old (following the categorization of Cloyne et al. (2018)) and old firms that are more than 15 years old. I present in Table 5 and in Figure 1 the characteristics of my two samples.

	N	%
Young	118070	60.48
Old	77159	39.52
Total	195229	100

Table 5: Sample divided by firms age

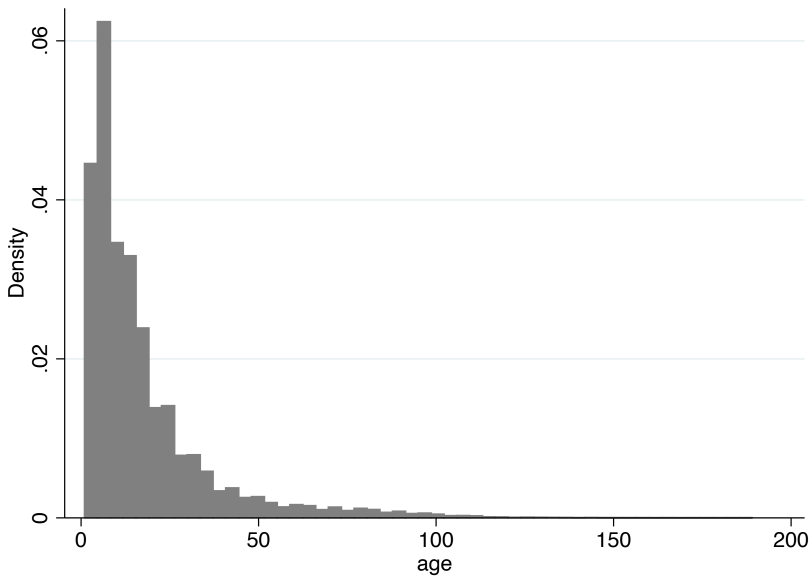

Figure 1: Density of firms by firms age

I run the estimator across the two different samples. I do not detrend by ages in the first step of my estimation. I find that the pass-through of young firms is large and significantly different from 0. On the contrary, the pass-through of old firms is not significantly different from 0.

	young	old
ϕ^{ε}	0.735**	0.700
	(2.01)	(0.97)
MPI	0.330**	0.161
N	14110	12002

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Sample divided by firms age

Then, firms that face financial constraints use change in current sales caused by a transitory income shock to invest. In constrast, unconstrained firms are not translating change in current sales into investment. It confirms the assumption that firms differ is their ability to invest up to their optimal level of capital. When they face different friction in accessing external financing they are constrained by their level of internal finance. Thus, such firms use changes in current sales caused by a transitory income shock to invest. In contrast, older firms, that are not constrained in their access to external finance are likely to be already investing up to their optimal level.

4.2 Liquidity

To go further in this investigation, I test one of the Jeenas (2020)'s results. He shows that firms with low liquid income react more to transitory income shock than the others. Indeed, firms that face fixed transaction costs in accessing external finance and don't have access to internal liquid asset use change in income to invest, even if they are not credit constrained and have strong balance-sheets. To test this theoretical result, I divide my sample in two taking the median of the ratio of asset liquidity as cut-off points (at 7.8%). I present in Table 7 and in Figure 2 the characteristics of my two samples.

	N	%
LowLiq	97615	50
HighLiq	97614	50
Total	195229	100

Table 7: Sample divided by firms liquidity ratio

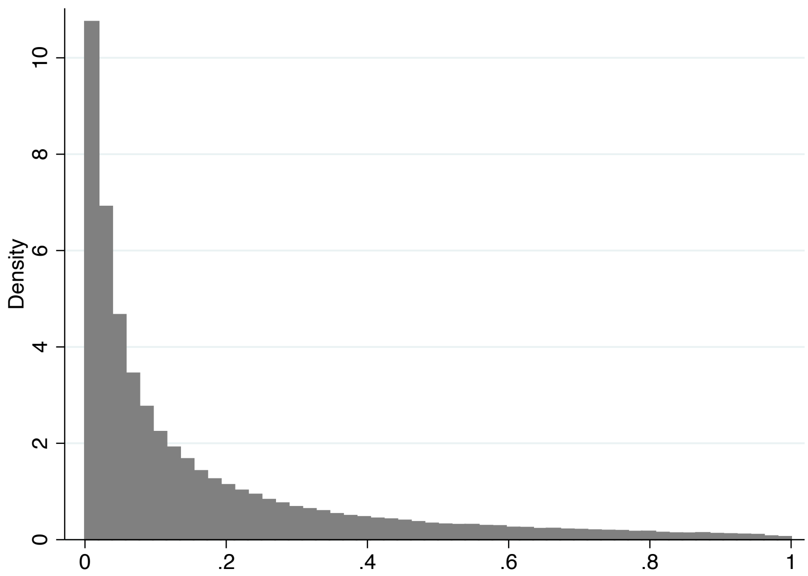

Figure 2: Density of firms by ratio of asset liquidy

I run the estimator across the two different samples. I find that the pass-through of low-liquid firms is large and significantly different from 0. On the contrary, the pass-through of firms with a high ratio of liquidity is not significantly different from 0. Then,

	lowliq	highliq
ϕ^{ε}	0.801***	0.358
	(2.73)	(0.80)
MPI	0.275***	0.0649
N	10753	16491

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Sample divided by firm liquidity

Then, firms' ratio of liquid assets seems to be an important determinant of the magnitude of the marginal property to invest of a firm. Firm that are liquididity constrained have high MPI. It can be explained by the existence of constraints on the access to external funding. Firms with low level of liquid assets use additional liquid funds to invest because then don't have the possibility to finance investment using liquid funds on hand otherwise. Firms with low level of liquid assets are not sensible to additional liquid fund because they could already relied on their liquid assets to invest if they wanted to.

4.3 "Wealthy Hand-to-mouth" Firms

Finally, I investigate whether I can observe the existence of what Jeenas (2020) labeled "wealthy hand-to-mouth" firms as a reference to the "wealthy hand-to-mouth" households model in the household literature (Kaplan and Violante (2014)). They are firms that are liquidity constrained but not financially constrained. They have strong balance-sheet but low-liquid asset holdings and he shows that they exhibit a high propensity to invest out of a liquid income shock in this model. To do that, I split my sample in four subsamples, by crossing the previously defined criteria.

	young_lowliq	young_highliq	old_lowliq	old_highliq
ϕ^{ε}	0.943**	0.412	0.707*	0.167
	(2.00)	(0.99)	(1.94)	(0.07)
MPI	0.490**	0.166	0.229*	0.0156
N	5917	8193	4836	8298

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Sample divided by firm age and liquidity ratio

Jeenas (2020) shows that the existence of issuance costs generates the presence of relatively wealthy firms that do not face financial constraints but exhibit large marginal propensities to invest out of liquid income shock. Because there exist cost to access external finance, firms prefer to fund their current investment using internal funds. But, those firms have already invested all their source of liquid funds to buy capital. We can see on Table 9 that I uncover the existence of such firms. Old firms, that are not financially constrained but which are liquidity constrained exhibit high and significantly different from 0 marginal propensities to invest.

4.4 Sectors

The last dimension of heterogeneity that I investigate is the sector of firms. The investment behavior of firms should differ across sectors. Moreover, it is well known that firms react differently to policies depending on their sector, for instance, Durante et al. (2020) shows that firm sector is an important determinant of firms' response to monetary policy). Heterogeneous MPIs could be a new element to understand this heterogeneity. The different sectors are :

1. Agriculture, forestry, and fishing

2. Mining

3. Manufacturing

4. Transportation, communications, electric, gas, and sanitary services

5. Wholesale trade

6. Retail trade

7. Construction

8. Services

I present in Table 10 the proportion of firms in my database over the different subsamples.

	N	%
1	1003	0.52
2	11620	6.03
3	100629	52.27
4	12991	6.75
5	9591	4.98
6	17079	8.87
7	3014	1.56
8	36585	19.00
Total	192512	100

Table 10: Sample divided by firm sector

As I split my initial sample in 8 subsamples I lose statistical precision. For instance, there are two sectors with less than 1000 observations, what makes difficult to interpret the points estimate. However, we can still observe large difference in MPIs across sectors.

	sec1	sec2	sec3	sec4	sec5	sec6	sec7	sec8
ϕ^{ε}	-1.940	1.298*	0.870**	1.128*	-0.661	0.935*	0.278	0.372
	(-0.86)	(1.89)	(2.45)	(1.80)	(-0.42)	(1.94)	(0.92)	(0.73)
MPI	-0.783	1.375*	0.121**	0.719*	-0.0685	0.0995*	0.0210	0.120
N	140	1669	14112	1636	1015	2693	321	5342

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Sample divided by firm sector

Pass-trough and MPIs greater than one could be surprising. Statistically, it can be explained by the imprecision of the estimation, one being within the confidence interval. Otherwise, Greenwald (2019) shows that interest coverage covenants (that set a maximum ratio of interest payments to earnings) and covenant that set a maximum on the ratio of the stock of debt to earnings are widely used in firm debt contracts. Then, transitory shocks to income could be used to relax those constraints and to raise external finance in addition to be directly invested. I will investigate further this channel in future work.

Durante et al. (2020) study the heterogeneous responses to monetary policy of firms in three sectors, manufacturing, construction and services. They show that construction and manufacturing firms react more to monetary policy than firms in services. They include in services firms that correspond to the sectors 4 (Transportation, communications, electric, gas, and sanitary services), 5 (Wholesale trade) 6 (Retail trade) and 8 (Services).

	N	%
Sector 4	12991	17.04
Sector 5	9591	12.58
Sector 6	17079	22.40
Sector 8	36585	47.98
Total	76246	100

Table 12: Pooling of Firms in Services

I cannot say much about firms in construction sectors due to the low number of firms in my sample. In constrast, as shown in Table 13 when pooled, the elasticity of investment to a transitory sale shock in services is not significantly different from 0 when we can see in Table 11 that the elasticity of investment to a transitory sale shock in manufacturing in positive and significantly different from 0. But as shown in Table 11, the estimations are heterogeneous within this aggregate sector.

	Services
ϕ^{ε}	0.148
	(0.20)
MPI	0.0406
N	10686

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13: Firms in services

This finding can be used to explain Durante et al. (2020)'s findings. Indeed, higher firms' MPIs could explain part of the strongest of some firms to monetary policy. If monetary policy has an effect on firms' income, firms that have higher MPIs will react more to this policy.

5 Conclusion

In this paper, I use a semi-structural method to estimate the firms' marginal propensity to invest out of a transitory income shock. This method was developed in the consumption literature to estimate the households' marginal propensity to invest out of a transitory income shock. Different estimation of firms' MPIs coexist in the literature but they either rely on a test of cash-flow sensitivity developed in a corporate finance literature or on natural experiments. I show that this method works well to identify firms' MPI and that it overcomes obstacles encountered by the previous estimations. By making a difference between transitory and permanent income shocks, this method overcomes the endogeneity problem faced by the corporate finance literature. By using a large panel of firms over a large period of time, this method avoid relying on a unique and special event and allows the presence of very heterogeneous firms in the sample. However, my estimations are consistent with the rest of the literature. I estimate an average MPI of 14.4. Then, on average, in my sample, firms use about 14.4% of the change in current sales caused by a transitory income shock to invest. I show that those MPIs are heterogeneous across firms. Young firms that are likely to face financial constraints react strongly to transitory income shock, on the contrary, old firms that do not face financial constraints do not translate transitory income shock into investment. Then, I pursue this investigation and show that firms that face liquidity constraints also have higher MPIs than those who do not. Moreover, I cross those two criteria and I show that I can put in evidence the existence of "wealthy hand-to-mouth" firms. Old firms, that do not face financial constraints but have liquidity constraints have large MPIs. Finally, I study the MPIs heterogeneity across the sector of firms. I show that, MPIs differ a lot across sectors and the average estimation is driven by a small number of sectors. In future work, I will run those estimations on quarterly data. I also want to run those estimation on the Orbis database provided by Bureau van Dijk (BvD) that covers the universe of firms of the European countries. Moreover, I will investigate further the sensibility of firms' debt to transitory income shock to understand if transitory income shock play a role in relaxing different borrowing constraints based on earnings ratios.

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A Appendix

A.1 Data

A.1.1 Variables

Capital : I follow the perpetual inventory method to build my measure of capital k_{jt+1}, the end of period t capital stock of a firm j. To do that, I initialize the value of k_{jt+1}, the capital stock using the first available entry of PPEGT (level of gross plants, property, and equipment). Then, I iterate forward on this variable using PPENT, a measure of net investment. If there is one missing value of PPENT, I replace it with a linear interpolation using its previous and following value.

Real Sales : sales (SALE) deflated using CPI.

Age : I define the incorporation date as the minimum of the WorldScope variable, the CRSP date and the first date the firm appears in Compustat (following Cloyne et al. (2018)).

Sector : Sector is based on sic. I keep 8 sectors, 1 : agriculture , forestry, and fishing (sic < 10), 2 : mining (sic $\in$ [10, 14]), 3 : manufacturing (sic $\in$ [20,39]), 4 : transportation, communications, electric, gas, and sanitary services (sic $\in$ [40,49]), 5 : wholesale trade (sic $\in$ [50,51]), 6 : retail trade (sic $\in$ [52,59]), 7 : construction ($\in$ [15, 17]), 8 : services (sic $\in$ [70, 89]).

Leverage : Total debt (debt in current liabilities (dlc) + long-term debt (dltt)), over total assets (atq).

Tobin's Q : the ratio of market value of assets to book value of assets ((at + prccf*csho - ceq + txditc) / at).

Size Total Asset (at)
Real Value-Added Sales (sale) - cost of goods (cogs)

A.1.2 Sample Selection

I exclude

1. firms in finance, insurance, and real estate sectors (sic $\in$ [60, 67]) and public administration (sic $\in$ [91, 97])

2. firms not incorporated in the United States and that do not do business in dollars

3. firm-year observations with acquisitions larger than 5% percent of assets

4. firm-year observations such that sale, or total asset, or debt in current liabilities, or long term debt or cash and cash equivalent and cash and short term investment is negative

5. firm-year observations with leverage higher than 10 or with a liquidity ratio is larger than 1

6. sale growth in the top and bottom 0.5 percent of the distribution.

7. firm-year observations before a firm's first observation of Property, Plant and Equipment (Gross)

A.2 Identification

A.2.1 Order of the Moving Average

I show here that my estimation is robust in choosing an MA(1) and to use future log-income growth at time $t + 2$ to instrument the current log value-added growth. The elasticity is higher but in line with my main estimation.

	average
ϕ^{ε}	0.733***
	(7.80)
MPI	0.189***
N	31479

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 14: Pass-through of transitory shocks to investment

A.2.2 Detrending

I am confident that using the Commault (2021) version of the BPP estimator and distinguish between transitory and permanent income shock allows me to avoid endogeneity biais. Recent work in the corporate finance literature that study cash-flow investment sensitivity use employment growth to control for investment opportunities and reduces this bias (see Mulier et al. (2016)). Indeed, Mulier et al. (2016) shows that investment growth is a proxy for investment opportunities. I show here that my estimation is robust to the inclusion of this proxy when detrenting my main variables. The point estimate is slightly lower but is in line with my main estimation.

	With emp. as control
ϕ^{ε}	0.463**
	(2.00)
MPI	0.122**
N	23994

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 15: Pass-through of transitory shocks to investment controlling for employment growth

A.2.3 Measure of Firm Income

Guiso et al. (2005) use value-added when studying firm performance. I focus here on a slightly different object but I show that my estimation is robust of this change in measure of firm income. They use value-added saying that, it the variable that is the most subject to stochastic shocks. I detrend this variable using the same variables as in the main part of this paper.

Table 16: Covariances of log-va growth

	$\Delta \log(y\_i, t)$	$\Delta \log(y_{i,t+1})$	$\Delta \log(y_{i,t+2})$	$\Delta \log(y_{i,t+3})$	$\Delta \log(y_{i,t+4})$
$cov(\Delta \log(y_{i,t}, .)$	0.240***	-0.117***	0.00243	0.00197	-0.00173
	(15.59)	(-11.57)	(0.44)	(0.53)	(-0.40)
N	12713	12713	12713	10277	8335

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The analysis of the covariances of log-va growth shows that, I can select simply future log-income growth at time t+1 to instrument the current log value-added growth. Indeed, the autocovariance is statistically significant up to $t + 1$ and stop being significantly different from 0 after that.

Table 17: Covariances of log-capital growth

	$\Delta\log(y_{i,t})$	$\Delta\log(y_{i,t+1})$	$\Delta\log(y_{i,t+2})$	$\Delta\log(y_{i,t+3})$	$\Delta\log(y_{i,t+4})$
$cov(\Delta\log(k_{i,t+1},.)$	0.0583***	-0.0542***	-0.00198	-0.0000749	-0.000161
	(10.67)	(-13.23)	(-0.78)	(-0.04)	(-0.08)
N	12713	12713	12713	10277	8335

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

I show in Table 17 that the covariances between detrended investment and current and future detrended log value-added growth. We can see that the variation in firm's value-added is correlated to the investment variation. Then, the covariances between detrended investment at time t and the future detrended log-income growth at time $t+1$ is statistically different from 0.

	Value-Added
ϕ^{ε}_{va}	0.457***
	(19.85)
N	15807

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The elasticity is still significantly different from. The point estimate is slightly higher than in my main estimation.

A.3 Method

A.3.1 Bound on MPIs

I show here that firms that are the most responsive to transitory income shocks are also on average the ones with the highest ratios of capital over income.

	Ratio
Young	.45
Old	.23
HighLiq	.18
LowLiq	.34

Table 18: Pass-through of transitory shocks to investment

A.3.2 AR(1) permanent income

I present here the result of a different income process specification. I assumed in the main part of this paper that permanent income was a random walk. I show here that my results hold if I choose a more general specification. I present here the result of my main estimation when the permanent process is modeled as an AR(1) process i.e. as

$$p_{j,t} = \rho p_{j,t-1} + \eta_{j,t}$$

With ρ the persistence of the AR(1). If the permanent process is indeed an AR(1) with $\rho \neq 1$, my estimation also captures the change in the effect of the permanent shock. Following Kaplan and Violante (2010), a consistent estimator of the elasticity under this specification is :

$$\hat{\phi}^{\varepsilon}_{AR(1)} = \frac{cov(\Delta \log(k_{j,t}) - \Delta \log(y_{j,t+3}))}{cov(\Delta \log(y_{j,t}) - \Delta \log(y_{j,t+3}))}$$

	$\rho = 0.95$
$\phi^{\varepsilon}_{AR(1)}$	0.899^{*}
	(1.66)
MPI	0.237^{*}
N	27244

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 19: Pass-through of transitory shocks to investment with an AR(1)

It shows that, with $\rho = 0.95$, the elasticity is still significantly different from 0.