IDB WORKING PAPER SERIES Nº IDB-WP-580

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Exploring a Commodity Boom

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July 2015

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Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Hansen, Erwin.
Multinationals stockpiling cash: exploring a commodity boom / Erwin Hansen, Rodrigo Wagner.
p. cm. — (IDB Working Paper Series ; 580)
Includes bibliographic references.
1. International business enterprises—South America. 2. Corporations—Cash position— South America. 3. Investments, Foreign—South America. I. Wagner, Rodrigo. II. Inter-American Development Bank. Department of Research and Chief Economist. IV. Title. V. Series.
IDB-WP-580

http://www.iadb.org

Abstract[1]

This paper explores how affiliates of multinational corporations save liquidity when facing a transitory cash-flow shock. For this a panel is first built of non-publicly traded copper mines in South America between 2001 and 2012, most of them set up as Foreign Direct Investment (FDI). This industry offers a peculiar advantage as a laboratory for social science when exploring cash-flow sensitivity: given time to build, investment decisions depend on the expectations of the long-run price of copper, while current cash flows depend only on the spot commodity's price. Although a robust effect of cash flow on current capital expenditures is not found, a much clearer picture is observed of the effects of transitory earnings on cash stockpiling: out of every extra dollar in cash, between 20 and 50 cents end up as extra cash holdings, especially among the most financially constrained firms. This was salient in the aggregate, since average cash holdings tripled as a share of assets during the commodity boom. The findings support financial theories remarking the salience of cash as a buffer stock for liquidity of financially constrained firms. Although the reinvestment of multinationals' earning is considered Foreign Direct *Investment* in the Balance of Payments, at least in the short run, a significant fraction of it does not constitute new investment in the National Accounts, since it remains among current rather than fixed assets.

JEL Classification: F23, F32, G31, G32

Keywords: Multinationals, Cash Holdings, Investment, Current Account Deficits

[1] The authors acknowledge the valuable conversations with Ricardo Bebczuk, Matias Braun, Jaime Casassus, Eduardo Cavallo and Fritz Foley, as well as seminar participants in conferences at the Inter-American Development Bank's Research Department, U of Chile's School of Economics and Business, Universidad Adolfo Ibanez, the University of of Chile's Center of Applied Economics (CEA), Central Bank of Chile. Joaquin Dagnino deserves special recognition for his superb work as Research Assistant. Carla Tokman provided excellent editorial and analytic help. The authors acknowledge financial support from the Inter-American Development Bank's competitive call for proposals on Savings in Latin America (2013-2014). The usual disclaimers apply in the sense that only the authors are responsible for the views, errors and ideas presented in this paper.

1 Introduction

The last half century has witnessed an explosion of theoretical and empirical research on corporate savings and, more recently, on how investment and cash holdings of corporations change with additional earnings Almeida, Campello and Weisbach (2004), Fazzari, Hubbard and Petersen (1987), Kaplan and Zingales (1997). In this paper we explore this behavior within what is usually a black box: the affiliates of commodity multinationals operating abroad. This type of corporation could be very important for emerging and less developed economies. In fact, for some commodity-dependent economies retained earnings of multinationals could be among the largest sources of new FDI.[2] Our goal is to understand how much of the additional cash flow is stockpiled and how much is invested. We follow the literature, focusing on the most financially constrained firms. Overall, we center our attention on cash holdings not only because of their major increase during the recent commodity boom (when the share of cash holdings in balance sheet assets tripled), but also because many casual analyses assume that corporate savings of multinationals end up always as current investment, given that they are called foreign direct *investment* in the Balance of Payments. We show, however, that a relevant fraction stays in cash.

To explore this question we built a panel of non-publicly traded copper mining companies, almost all of them subsidiaries or affiliates of MNCs operating in Chile and Peru between 2001 and 2012. We focus on this industry because there is relevant time to build for new investments and particularly because there is a plausible way to isolate a transitory cash flow shock from a shock to longer-term profitability. Current profits depend on the spot price of copper, while investment may depend on the expectations of future prices. The period under study had the particularity of having relevant differences between long and short-run prices, which we use to identify the effects of transitory cash flow shocks.

Our preferred specifications show that for financially constrained firms around 20-50 cents of every extra dollar of cash flow end up as extra cash holdings, with the cash flow sensitivity of investment being usually smaller and much less robust. Overall, the reported evidence is consistent with corporate cash flow stockpiling as an option value for future investment due to both technological and tax-induced inaction zones.

[2] In Chile, for example, MNCs' savings are as important as the savings made by all domestic corporations, as shown in a contemporary paper by the same authors. According to the Global Investment Report UNCTAD (2013), multinationals' corporate savings around the world amount to about half a trillion dollars. Roughly speaking, one out of three dollars of MNCs' corporate income represents retained earnings, which are are used either as investment in fixed assets or to expand net cash holdings. A country hosting FDI could have many natural questions about MNCs' use of funds. For example, if the host country is considering a temporary increase in corporate taxes, therefore reducing MNCs' cash-flows, it is important to know whether all positive NPV projects will be undertaken anyway, using additional external funds, or in contrast, whether the shortage of internal liquidity could prevent some good projects from happening. In those discussions, understanding the propensity of corporations to save as well as the allocation of those savings seems essential.

This paper is related to several branches of the literature. For the case of MNCs, the focus has been on understanding why these companies keep so much cash in their subsidiaries abroad rather than centralizing all of its management as suggested by basic Multinational Finance textbooks. Foley, Hartzell, Titman and Twite (2007) argue that this is due to tax considerations, especially repatriation taxes. Campbell, Dhaliwal, Krull and Schwab (2014) argue that transaction costs, precautionary motives and MNCs' ability to raise external funds also help to explain this pattern.[3]

We are different from the above studies in the sense of attempting a causal identification of transitory corporate profits on cash holdings. Like other Finance scholars we sacrifice the generalizability of the results in order to explore a specific context in which a phenomenon is feasible to measure or easier to identify (e.g., Blanchard, Lopez-de Silanes and Shleifer (1994); Tufano (1996)). Our case configures a useful laboratory for social science, keeping keeping in mind that the instrumented effects are only local for those who changed behavior due to the cash flow shock in this context, or what Imbens and Angrist (1994) called *compliers*.

Clearly, beyond multinationals, there is a large literature measuring the so called cash flow sensitivity of investment and cash flow sensitivity of cash holdings. The former started with the seminal work of Fazzari et al. (1987), and shows that financially constrained firms are sensitive to cash flow. For these firms the internal cost of funding is lower than the external one. The latter branches from the work of Almeida et al. (2004), who propose a model of demand for liquidity based on the idea that firms anticipating future financing constraints decide to hold more cash today at the cost of reducing some current investment opportunities. Thus firms hold cash, balancing the profitability of current and future investments. Gatchev, Pulvino and Tarhan (2010) and Dasgupta, Noe and Wang (2011) explore how cash flows are dynamically allocated to investment, cash holdings, dividends or debt payments, for a large sample of U.S. firms. Both show that an important share of the new cash flow ends up as extra cash, especially for financially constrained firms. Our findings of cash holdings being very sensitive to cash flows, more robustly so than investment's sensitivity, coincide with their work. Within this cash flow sensitivity literature we seek to contribute to the much less extensive set of papers that are identified with a strategy beyond lags and other covariates. Blanchard et al. (1994) explore 11 event studies in which companies

[3] Our paper also relates to the general literature exploring the management of liquidity by corporations. Almeida, Campello, Cunha and Weisbach (2013) propose a framework of forward-looking corporations in which the main determinants of the management of liquidity are the financial constraints they face and the desire for efficient financing for *future* investment. Other studies focus on different mechanisms and more specific contexts. Bates, Kahle and Stulz (2009) study why U.S. firms hold so much cash, arguing that this is due to cash flow riskiness. Horioka and Terada-Hagiwara (2013) study the determinants of cash holdings in Asia. Campello, Graham and Harvey (2010) and Campello, Giambona, Graham and Harvey (2011), document the interaction between internal funds, external funds and real decisions during the recent 2008-2009 financial crisis, concluding that firms do use cash instead of external funds, and that firms substitute cash savings for investments in a sample of developed countries.

were awarded a cash windfall after a judicial procedure. Lamont (1997) explores internal capital markets of conglomerates (multi-segment firms) that include an oil company, looking at the oil price drop in 1986. He finds that non-oil companies in these conglomerates had a sharp drop in investment.[4] Looking at a much broader sample, Rauh (2006) exploits the cash flow shocks induced by unpredicted returns of corporate pension plans for employees, which if too small need to be compensated by the company. He finds that companies facing bad returns in their employee pension portfolio face significant drops in investment. In our results, given lumpiness and time to build in new mining operations, it is surprising that the response of investment to transitory earnings is more difficult to measure than that on cash holdings.[5]

The rest of the paper is structured as follows. Section 2 describes a simple theoretical framework. Section 3 explains the institutional context of taxation and industry attributes that creates a so-called inaction zone in which firms may want to stockpile cash. Section 4 explains how we built our dataset, describing its main patterns. Section 5 is the center of our paper, estimating cash flow sensitivities of investment and cash holdings, while Section 6 performs a series of robustness checks. Finally, Section 7 concludes with some remarks.

2 Theoretical Framework

While the contribution of this paper is essentially empirical, in order to even attempt identification, we show a very stylized framework that helps us outline our empirical strategy. This theoretical framework is a reduced-form adaptation of Almeida et al. (2004), who explore the inter-temporal decision of corporations to save in cash holdings. This is a suitable starting point given time to build. In their model financially constrained firms choose their optimal stock of cash holdings h^*as a result of a trade-off between the marginal cost of hoarding an extra unit of cash $C'(h_t)$ and the

[4] In the last decade various studies have used movements in the main export commodities of a country as a shifter for its exchange rate (e.g., Cashin, Céspedes and Sahay (2004), Chen and Rogoff (2003), Chen, Rogoff and Rossi (2010)).

[5] Andrén and Jankensgård (2015) also use a relatively smaller sample of firms to study how commodity price changes impact funding, in their case in the gas and oil industry. They find that financially constrained firms reduce their investment sensitivity to earnings when commodity prices jumped. There are, nonetheless, significant differences with their approach. First, we study the sensitivity of both investment and cash holdings to changes in earnings. Second, we focus only on liquidity movements that were plausibly unrelated to long-term profitability. Those authors argue that they identify a shift in liquidity, not only because of earnings but also because the assets of the company became more valuable after the commodity boom, which allowed them to take extra debt. Unfortunately, that shock to liquidity is by construction correlated with the expectation of future investment opportunities (the demand for funding), so both the supply and demand for funds within firms are moving, which does not allow for identification of the effect of funding. Moreover, they only report changes in cash flow sensitivity. A third and related difference of our paper is that we explicitly use an instrumental variables approach to identify the liquidity shock and separate it from long-term profitability.

We are also close to Hovakimian (2009), who looks for the determinants of investment cash flow sensitivity of cash. Again, our innovation vis-a-vis these papers is the interest in causality, particularly in regard to cash holding rather than investment. Carter, Rogers and Simkins (2006) also use a relatively small panel, but in the airline industry, to explore how hedging impacts a company's value after oil price changes.

marginal benefit of doing so $B'(h_t)$. The cost of cash today is essentially the opportunity cost of *not* undertaking a positive NPV *current* project, which without loss of generality could also be investing outside the firm. In contrast, the benefit of increasing savings of cash within the firm is determined by the option of investing in the future, plus some basic liquidity needs. Adapting the framework of Almeida et al. (2004)[6] we find that at the optimum the familiar condition of marginal costs and benefits equalize:

$$C'(h_t, X^C) = B'(h_t, X^B);$$

where X^C and X^B are variables that shift the marginal cost and benefit curves above. A crucial distinction is that for financially constrained firms the marginal cost is the internal marginal cost of resources $C'_{int}(h_t, X^C)$. In contrast, for unconstrained firms the marginal cost is simply equal to the marginal cost of external funds, namely $C'(h_t, X^C) = r^{External}$.

Figure 1 depicts the graphical solution for optimal cash holdings, showing the effect of an exogenous and *transitory* increase in cash flow, which shifts the marginal cost of internal funds to the right without moving the benefits of investment.

In preparation for our empirical exercise in Section 5 a few considerations are in order. First, it is important to note that the marginal benefit curve of holding cash $B'(h_t, X^B)$ does in fact move when there is a shift in future investment opportunities (for example due to an increase in the expected long-run price $P_t^{LR} \in X^B$), but only for financially constrained firms. In contrast, for financially unconstrained firms the same shift in investment opportunities does *not* translate into a shift in marginal benefit of holding cash $B'(h)$, since resources for this future investment could be financed externally in the future, so there is no additional investment option value of stockpiling cash today.

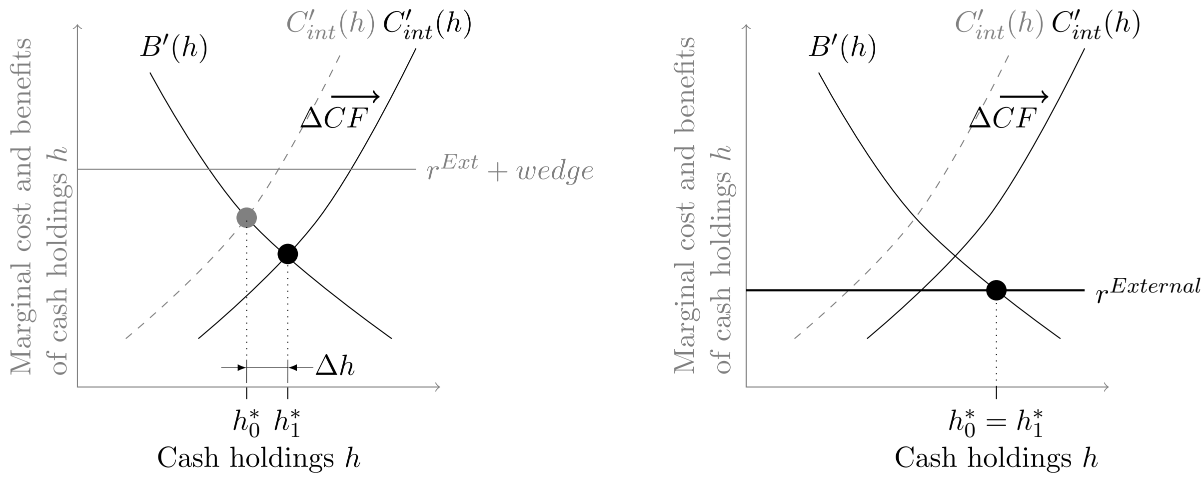
There is an important distinction between a transitory and a permanent (long-run) price change. As mentioned, the shift in transitory cash flows shifts only the cost curve $C'(.)$ to the right, while *ceteris paribus* the benefits of holding cash $B'(.)$ do not move, predicting an increase in cash holdings. In contrast, a change in the long-run price of copper moves both the marginal cost and marginal benefits of holding cash, and they could even move in different directions. In particular, for financially constrained firms there is an increase in the value of investing cash holdings *today* (even if those investments will not pay off soon, due to time-to-build). This shifts the marginal cost curve $C'(.)$ to the left by more than what the benefit of holding cash $B'(.)$ moves to the right. In that case the framework would predict that a jump in the expected long-run price of the commodity is associated with a *reduction* in cash holdings, not an increase. This is important at the time of interpreting the effect of a jump in the permanent long-run price on cash holdings, which could go in the opposite direction than the well-known effect of long-term profitability on investment, which

[6] See their equation (4).

Figure 1. Effect of an Exogenous Cash Flow Shock CF_t on Optimal Cash Holdings h^* Depending on Whether the Firm is Financially Constrained or Not

(a) Optimal Cash holdings h^* for Constrained Firms : $C'_{int}(h^*_t) = B'(h^*_t)$

(b) Optimal Cash holdings h^* for Unconstrained Firms: $r^{External} = B'(h^*_t)$



Note: Each plot depicts the internal capital market of each firm regarding the costs and benefits of holding additional cash in its balance sheet h when there is a positive shock to cash flows CF_t,which implies a shift to the right of the marginal cost of cash holdings $C'(h)$. For constrained firms there is a positive cash-flow sensitivity of cash holdings, because optimal cash flows h^*increase with an exogenous CF_t shock. In contrast, for financially unconstrained firms the relevant decision is always mediated by the intersection of the marginal benefit of holding cash and the marginal cost of obtaining cash from external sources $r^{External}$, not internal sources. The intersection of these two curves does *not* change when there is a shift in the internal marginal cost of cash $C'_{int}(h)$. It is important to note that the marginal benefit curve of holding cash does move when there is a shift in future investment opportunities, but only for constrained firms. In our empirical setting we aim to control for such opportunities using the long-run price of the commodity, which helps to keep the marginal benefit curve $B'(h)$ constant. For unconstrained firms a jump in long-run fundamentals does indeed move the future demand for investment, but unlike for constrained firms, for unconstrained firms that does not translate into a shift in marginal benefit of holding cash $B'(h)$, since resources could be financed externally so there is no additional investment option value of stockpiling cash, which is what determines $B'(h)$.

is always positive. We do not discuss a specific framework for investment's sensitivity to current earnings, since it is already well treated in the literature, but it can also be represented as supply and demand of funds within the firm. It is important to remark, though, that an increase in long-term price generates more investment today, which increases the opportunity cost of holding cash and therefore reduces optimal cash holdings today. This discussion is just to frame the interpretation of the long-run price coefficient's sign on the regressions explaining investment (+) and cash savings (-). These signs are important for the consistency of our empirical work, but they are not our main coefficient of interest, since we focus on the transitory component of cash rather than long-run profitability.

In our empirical setting we control for shifts in future investment opportunities using the long-run price of the commodity, which helps us keep the marginal benefit curve $B'(h)$ constant, allowing us to identify the effect of one dollar of extra cash today, not a permanently higher profitability.

Given the simple model above, the testable prediction is as follows: *Financially constrained firms display a positive cash flow sensitivity to cash holdings*.[7] Having established our testable propositions from this very stylized framework, we now turn to a description of the institutional and technological context in which these firms operate.

3 Institutional and Technological Context

In this section we briefly describe the institutional context and the attributes that make it useful for our identification strategy. Chile is a very open country for foreign investors, with Foreign Direct Investment (FDI) representing around a third of Gross Fixed Capital Formation UNCTAD (2013). Around half of that FDI involves mining companies, and the rest is invested mostly in non-traded goods. In this paper we focus on mining since we argue that there is a relatively cleaner channel for identification. Below we will discuss two distinctive aspects of our context: type of corporate taxation and time-to-build in mining investments.

3.1 Taxation

Foley et al. (2007) argue that part of the additional cash stockpiling in a large sample of U.S. listed multinationals is due to tax reasons. The basic idea is that firms are aware of the tax considerations of repatriation, generating an inaction zone in which MNCs do not want to repatriate dividends even if they are not investing immediately. The integrated tax system in Chile has particularities inducing an investment inaction zone, in which companies save cash out of temporary windfalls, as we explain below. First, all firm owners in Chile, including MNCs, pay (personal) income taxes for their corporate profits only on the amount that is not retained in the company. So the income from corporate sources received by a citizen or a foreign corporation is taxed on a cash basis rather than an accrual basis. Importantly,[8] the corporate income tax paid is a credit for that final income tax paid by citizens of foreign corporations. To be specific, most copper mining companies in Chile are subject to an income tax of 35% for the cash they repatriate to headquarters. So if they generated $100 in profits this year, they needed to pay immediately $19 in corporate taxes (19% rate), meaning they keep $81 after corporate tax. If the mining company chooses to pay out these $81 as dividends to headquarters, then headquarters would receive only $65 (i.e., a 35% overall tax rate for repatriation, to which the 19% was a credit). That would be the best-case scenario

[7] Although the center of our paper is not to test for investment, for completeness we also follow some recent papers (e.g., Gatchev et al. (2010) Dasgupta et al. (2011)), also testing the cash flow sensitivity of investment among constrained firms, although not jointly as they do. With less data we prefer to keep the exercise as clean as possible.

[8] After the very recent 2014 tax reform there will be only partial tax integration for some large companies, although the extent to which this would apply to mining companies is still an open question, since some of these projects started under tax invariability agreement DL600, and others have additional protections against tax changes granted as part of the trade and investment treaties that Chile has with many countries.

assuming that the headquarters'country does not have any additional repatriation taxes. In this context the MNC's CFO is hesitant to repatriate taxes: it would be very costly to bring home $65 if you think there is a chance of investing them later in Chile, instead of keeping the $81 in Chile as cash or investing it in publicly traded securities. Moreover, most mining corporations use an umbrella company as a vehicle for their operations, and the income tax of 35% should be paid only after cash is paid from the umbrella corporation, not the individual mine. This legal adaptation is made under the understanding that copper mining works in a series of subsequent projects, so the large CAPEX of a new project overlaps and smooths taxes of ongoing projects. There are almost no restrictions on the kinds of investments that firms can undertake, also including so called passive investment in other financial securities. This generates further incentives to retain earnings in Chile rather than paying out. In short, this is a specific setting in which multinationals could be holding cash due to tax reasons. While the tax system is quantitatively different for the two mining companies located in Peru, it is qualitatively similar in terms of the incentives to retain cash.[9]

3.2 Investment in Copper

Investment in copper takes time both to execute and to be profitable. This is relevant for our exclusion restriction, because what defines the IRR of an investment project is the expectation of long-run prices, not the spot price.[10]

Copper deposits contain a relatively low concentration of the metal, around half of a percentage point, with most of the rest being unwanted rock and a few byproducts. This means that after mining there is a relevant sequence of stages to increase the concentration of the metal. In particular, producing copper metal has four stages: mining (which produces ores), concentrating, smelting, and refining (which produces pure copper metal). A relevant share of firms in Chile export concentrate rather than final copper cathodes, but these prices are still connected to the LME spot price of copper.[11] Concentration of copper requires significant investments, and the size of these operations usually determines the current capacity of the mine. Building these concentration plants could take one or two years even when the engineering plan is fully ready, as discussed by Burgin (1974). [12].

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[9] Dropping these firms did not impact the sign of our point estimates in our preferred specifications.

[10] For example Radetzki and Van Duyne (1984) documents a slow adjustment of actual investment after a drop in copper prices some 30-40 years ago.

[11] Escondida mine, the largest copper mine in the world and a joint venture of BHP Billiton, is a relevant case. Before providing project finance for this mine in the late 1980s and 1990s banks requested that the mine sign a long-term agreement with big smelters in Asia, therefore hedging potential contractual risk. In any case, the great majority of the contracts during our sample period do show sensitivity of contractual terms to the spot price of copper on the London Metal Exchange (LME).

[12] To have an idea of other time delays, the project of developing the underground operations of the Chuquicamata mine in Chile has taken 3-5 years only in its engineering phase, before even a single tunnel is built. Then there are additional and important delays on the order of 2-3 years in construction of tunnels until copper is extracted. Another way of extracting copper is above ground, in what is called an "open pit" mine. In that case firms could theoretically

In short, if firms were theoretically informed about a transitory shock to copper prices that would last for a year or two (assuming that signal is possible), then there would be little margin for an investment response. These delays are, therefore, useful for our exclusion restriction that the transitory component of spot prices should not impact current investment beyond its indirect effect on liquidity.

We are not the only ones using copper as a lab for social science. In fact, Slade (2013) tests her options model, arguing "*investment in copper mining provides an ideal laboratory in which to test the predictions of the theory of real options with time to build. Indeed, projects are large, prices are highly variable, investment is infrequent, and completion takes several years*." For the same reasons this setting can mitigate the endogeneity concerns that are frequent in the cash-flow sensitivity literature.

Overall, we do not pretend that these results are necessarily representative of other industries. Our point is given the taxation and internal dynamics for cash in copper, if our results are not conclusive in this context, then it would be hard to believe that these theories of dynamic cash stockpiling can have traction in other settings where the fundamentals of the business are less conducive to that behavior.[13]

After this description of the context we now turn to the actual construction of our dataset and later to the estimation of cash-flow sensitivities.

4 Data Construction and Description

4.1 Building Our Panel of Copper Mines

Using several sources we built an unbalanced panel dataset of mining firms operating in the copper sector in Chile, combining it with some Peruvian mines, almost all branches of multinationals. This was challenging because these are not publicly traded firms, even though some of them are subsidiaries or branches of publicly traded companies. Our dataset, which is available on the authors' website, contains annual Balance Sheet and Income Statement information for each of the

invest in more shovels to extract copper in reaction to spot prices. But usually these are already optimized to meet the capacity of the concentration stage which, as mentioned, has relevant delays for expansion. For applied models of the real option to start an investment and for mining exploration see Cortazar and Casassus (1998), Cortazar, Schwartz and Casassus (2001)

[13] Copper projects are a series of real options, where mines are developed in stages, each of which requires important delays. This sequencing of projects makes it very salient to understand the use of internal cash flows, which come from previous stages of the mine that are in operation and go to finance later stages of the mine and the concentration plant that are under development. Using the jargon of Rajan and Zingales (1998), copper mining is relatively intensive in internal cash flows. As a matter of contrast, a company that only owns a single hydroelectric power plant would need all external funds for its initial CAPEX (building the dam), while facing almost no reinvestment opportunities, since the dam is already built. In a copper mine both the operations within each mine and the sequencing of projects within a single firm/branch make it a more interesting arena for the study of the use of internal funds and the dynamics of cash.

MNCs' copper projects in operation in Chile and Peru during the period 2001-2012. We selected this period given data availability and because it has enough variation in commodity prices. The sample starts a few years before prices start to rise. The total number of mines is N=19, while the total number of observations in the panel is 198. The dataset is comprehensive as it includes all the MNCs and projects in Chile during the analyzed period. It is worth noting that MNCs are responsible for around 50% of copper production in Chile, with the rest being produced by state-owned copper company, CODELCO. The dataset was hand-collected from two public sources: from 2000 to 2006, we relied on the information provided by "*Consejo Minero*", a mining association whose members are the large mining companies operating in the copper, gold, silver and molybdenum sectors in Chile. "*Consejo Minero*" collects balance sheet, income statement and production data, among other information, directly from their associates, and then publishes an annual report. Our second source of information is the securities regulator (*Superintendecia de Valores y Seguros*, SVS, the equivalent of the SEC in the United States). By law, since 2007 MNCs operating in Chile under the DL600 foreign investors tax scheme must report detailed financial information to SVS. It is therefore our main source of information for 2007-2012. As for Chile, for the Peruvian mines we combine data from the securities regulator and individual reports of these companies. Whenever possible we checked the consistency of the two sources in order to avoid potential misreporting. In many cases data were reported in local currency (e.g., millions of Chilean pesos for each year). We deflate and convert the data to real U.S. dollars of 2000, using the corresponding U.S. CPI and end-of-year US dollar/peso exchange rates series when needed. One limitation of a our relatively short panel, at most 12 yearly observations per firm, is that we cannot attempt to exploit the dynamics of the panel to identify lagged effects of investment.

4.2 Variables and Descriptive Statistics

Using the information retrieved from MNCs' balance sheets and income statements, and basic accounting identities, we build the variables used in the empirical analysis below. From the balance sheet, total assets (TA) are divided between current assets (CA) and fixed assets (FA). CA and FA are used as dependent variables in different specifications later on. Current assets are later decomposed into cash holdings (CASH), account receivables (AR), inventory (MDS) and other current assets (OCA) in order to track the use of retained cash-flow. We also used as dependent variable the level of MNCs' investment (I). This variable is measured as the change in gross fixed assets plus depreciation. From the income statement, we build our cash flow measures. Cash flow (CF) is straightforwardly defined as earnings/losses plus depreciation. This measure of free cash flow is used to estimate both the cash flow sensitivity of cash and the cash flow sensitivity of investment in our baseline results. Retained earnings (RE) are defined as free cash flows minus dividend payments.

Table 1 reports the descriptive statistics of the main variables in the analysis. The variables reported as percentages were scaled by current total assets. In our sample, cash holdings as a stock represents 13% of total assets. This number is large and highlights the importance of understanding this phenomenon. Current assets, a broader measure of liquidity, represent as a stock around a third of total assets, whereas the remaining two-thirds of total assets are fixed assets. When we look at these variables as flows, we observe that changes in cash holdings represent 7% of total assets and current assets are 9% of total assets. Our measure of investment is even larger, reaching 21% of total assets. The volatility of investment, measured by its standard deviation, is quite large (60%), as expected from models of lumpy investment. Free cash flows for these companies are important, averaging 38% of total assets, with a volatility level of 32%. Recall this is a boom. Regarding other control variables, the firm's leverage in our sample is around 40%. Out of this total debt, 40% is short-term debt (15% of total assets), and the remaining 60% is long term (25% of total assets).

Guided by previous literature and data availability we define a set of control variables to be included in our estimations. Our first control is size as logarithm of total assets. One issue with this measure is that over time the size of companies grows with the long-run copper price boom in our sample period, complicating the interpretation of the price coefficient. As a way to ease interpretation of the price we included only the component of (log) size that is orthogonal to long run price. This does not impact the main coefficient of interest, which is that on short-run cash flows. A second standard control is leverage, defined as the ratio of total liabilities and total assets.

Finally, we collect spot and future market prices of copper from Bloomberg. In particular, the spot price corresponds to the annual average of the weekly spot copper prices in the London Metal Exchange, and the futures price is the 27-month rolling forward copper price at the London Metal Exchange. In some specifications we include them as control variables while in others we build a spread (spot price – future price) that we use as instrument in our IV estimations, including also the interest rate as a control to distill expectations of future prices. Figures 2 and 3 in the Appendix show the time series of the spot and future price of copper from 1990 to 2013, as well as spot minus future spread for the same time span. Two features of the spread are worth mentioning: first, it shows considerable variation through time; and second, it shows large swings which can help us as a valid shifter of cash-flows. We will come back to this point in Section 5. Finally, one could argue that long-run expectations might be better proxied by industry experts. Since each firm's estimations of long-run prices is in fact a corporate secret for mining companies, in a robustness check we use the long-run price expectations made by a panel of experts in Chile. This panel is the "*Comite Consultivo del Precio de Referencia del Cobre*" assembled by the Budget Office. The opinions of these experts are winsorized and averaged, serving each year as input for fiscal planning in Chile.

Table 1. Descriptive Statistics

Variables and Controls	Obs	Mean	Std. Dev.	Min	Max
Stock Variables					
Cash (Stock)	189	0.134	0.165	0.000	0.755
Account Receivable (Stock)	189	0.061	0.059	0.000	0.359
Inventory (Stock)	189	0.068	0.059	0.000	0.299
Current Assets (Stock)	189	0.327	0.204	0.002	0.965
Fixed Assets (Stock)	189	0.673	0.204	0.034	0.998
Flow Variables					
ΔCash	189	0.067	0.296	-0.540	2.903
ΔAccounts Receivable	189	0.017	0.054	-0.155	0.339
ΔInventory	189	0.019	0.031	-0.063	0.138
ΔCurrent Assets	186	0.091	0.198	-0.453	0.946
ΔFixed Assets	184	0.096	0.187	-0.349	0.899
ΔRetained Earnigs	189	0.179	0.217	-0.399	1.189
Cash Flow	189	0.382	0.315	-0.054	1.420
Earnings	189	0.321	0.306	-0.087	1.310
Investment	189	0.214	0.596	-0.145	6.809
Other Controls					
Leverage	189	0.402	0.223	0.052	0.996
Short term Debt	189	0.155	0.117	0.009	0.709
Long term Debt	189	0.251	0.210	0.000	0.911
3-year Interest Rate (%, $)	189	2.58	1.44	0.38	4.77
China GDP Growth Rate (%)	189	10.2	1.7	7.8	14.2
Commodity Index (Metals)	189	136.6	58.5	52.7	233.6

Note: The table shows descriptive statistics for the main variables in the analysis covering the period 2001-2012. All but the last three variables come from balance sheet and income statement information that MNCs operating in the copper sector in Chile must provide to the government regulatory agency (Superintendencia de Valores y Seguros, SVS). The 3-year interest rate is the yield on U.S. Treasury securities at 3 years with constant maturity. This series was retrieved from Federal Reserve Economic Data (FRED) available at the Federal Reserve Bank of St. Louis's website. The GDP growth rate of China and the Commodity Index for metals were obtained from the IMF's International Finance Statistics and the IMF Primary Commodity Prices dataset, respectively. Stock and flow variables, as well as the debt variables, are scaled by total assets.

4.3 Evolution of Asset Composition during a Commodity Price Boom

The phenomenon we study was very important in the Chilean copper industry during the last extended decade. Table 2 shows the evolution of some selected balance sheet components. Among them, the share of cash in total assets almost tripled, with other components of current assets qualitatively mimicking that trend. At the beginning of our sample period, when copper prices were around $1 per pound, cash holdings were in the ballpark of 5% of assets. As copper prices improved, the share of cash became around 15% of balance sheets. As a mirror we observe a decrease in the share of fixed assets. Although fixed assets were growing greatly in absolute terms, their share of the balance sheet decreased from some 85% to only about 60%. Mining became relatively more intensive in cash, and this paper is trying to explore whether this is related to cash flows.

5 Cash Flow Sensitivities

We study the impact of cash flow shocks on cash holdings and investment using the following baseline model

$$y_{i,t} = \beta\, CF_{i,t} + \gamma_1 P_t^{Long} + \gamma_2 X_{i,t} + \mu_i + u_{i,t} \tag{1}$$

where $y_{i,t}$ is either investment or the change in cash holdings, current assets or the change in fixed assets of the multinational company i in year t, depending on the selected specification. CF_t is the cash flow of the MNC, and our main variable of interest. The estimated coefficient β measures the cash flow sensitivity of $y_{i,t}$. As a central control we include the logarithm of long-run expectation of the price of copper (P_t^{Long}) in order to control for changes in the future investment opportunity set. Because branches of MNCs in our sample are not publicly listed firms, we cannot approximate this set by Tobin's Q, as is common in the literature. But at the same time we have the

Table 2. Averages by Year of Selected Balance Sheet Items as Share of Assets

	Assets		Detail of Current Assets		
Year	Current (CA)	Fixed (FA)	Cash (CASH)	Accounts Receivable (AR)	Inventory (MDS)
2001	0.16	0.84	0.05	0.02	0.04
2002	0.15	0.85	0.05	0.03	0.04
2003	0.20	0.80	0.07	0.04	0.05
2004	0.28	0.72	0.12	0.06	0.06
2005	0.36	0.64	0.17	0.07	0.06
2006	0.44	0.56	0.23	0.06	0.06
2007	0.43	0.57	0.18	0.07	0.07
2008	0.39	0.61	0.17	0.02	0.08
2009	0.39	0.61	0.17	0.09	0.08
2010	0.41	0.59	0.17	0.11	0.08
2011	0.38	0.62	0.16	0.07	0.09
2012	0.37	0.63	0.14	0.07	0.10

Note: The table reports average per year of selected MNCs' balance sheet variables during the period 2001-2012. CASH is cash holdings, AR is accounts receivable, MDS is inventory, CA is current assets and FA is fixed assets. All the variables are scaled by total assets of the previous period.

crucial advantage of observing one of the most important fundamentals that determine investment: proxies for expectations of long-term prices. Finally, $X_{i,t}$ is a set of additional control variables that can potentially vary by firm and year, such as size and leverage. In some specifications we include additional time-varying controls like Chinese growth and interest rates, among others. Notably, all specifications include a firm fixed effect μ_i, aiming to correct for time-invariant unobserved heterogeneity. Finally, $u_{i,t}$ is an unobserved random error term that we cluster at the firm level.

In the instrumented cases, we use z_t, namely the spread between the spot copper price and the expectation of the long-run price of copper. The first estimated jointly with equation 1 is then

$$CF_{i,t} = \eta z_t + \phi_1 P_t^{Long} + \phi_2 X_{i,t} + \widetilde{\mu}_i + \varepsilon_{i,t} \tag{2}$$

This aims to capture variation in cash flows CF_t that is unrelated to the unobserved term $u_{i,t}$ in equation 1.

First we estimate equation 1 using a panel fixed effect estimator with year fixed effects (OLS-FE) and, more substantially for our purposes, we use an instrumental variable fixed effect estimator (IV-FE). Recall that the equation already controls for long-run price expectations and in some specifications for the interest rate. We argue that this identification strategy is valid since the instrument z_t can simultaneously affect cash flows without necessarily affecting the level of investment of the MNCs. In other words, once controlling for long-run profitability due to future prices, the instrument can move the supply curve of cash for internal projects in the firm without moving the set of investment opportunities and without moving the marginal benefits of stockpiling cash for the option of future investment. Regarding cash holdings, the instrumented coefficient β indicates the effect of a shift in the marginal costs of funds without changing the benefits of holding cash.[14]

Recall that the IV estimates seek to capture *current* effects between cash flow and cash holdings, investment, current assets and fixed assets. For robustness, some specifications incorporate single lagged levels of the dependent variable, trying to address the persistence concerns in Gatchev et al. (2010), but constrained by the context of our smaller N study. Rather than doing something with more lags and structure, we prefer to focus on the current effects, which are certainly not the whole story of cash stockpiling, but it is what we can attempt to identify given our shock.

[14] Volatility could be important, but the nature of the change is already large and we have a hard time measuring volatility. During most of our sample we lack enough variation in the volatility of cash flows to independently identify that effect. Since we have at most 12 years of yearly data, a short rolling window to compute volatility would be almost collinear to price changes or size after we control for firm fixed effects. In contrast, when we leave a wide rolling window for cash flow volatility we have almost no variation, and it goes away with the firm fixed effect. Since the paper is already long and controls are potentially collinear with existing variables, we prefer to lean towards covariates of the first moment.

As outlined above, our main approach for instrumentation assumes that the variation in the spread between spot and forward, once corrected for other factors, represents the additional reward over and above the expectation of prices in the long run. Among the factors to correct is the risk-free interest rate in dollars for the same duration as the forward, which is done in all groups of specifications. Therefore we are implicitly including the convenience yield in the instrumented regression (i.e., spot minus forward minus interest rates), although in a more flexible form. Also, given that we are using forward or long-run prices as a control, we implicitly allow for a more flexible parametrization between this convenience yield and prices. In that context we would be implicitly including all three underlying factors described in Casassus and Collin-Dufresne (2005) for commodity pricing, but with the advantage of allowing the price and the interest rate to appear directly in the second stage regression as well.[15] In the robustness checks we also use some other fundamentals that could potentially be related to time-varying risk premia in commodities such as the Chinese growth rate. In some specifications, controlling for leverage also helps us explore whether it is borrowing rather than own cash savings that generates the additional stockpiling of liquidity. Controlling simultaneously for long-term prices and leverage mitigates the potential two-way causality between long-term profitability and leverage, which is common in the cash-flow sensitivity literature. For our empirical strategy this might be less relevant since long-term profitability, which affects the value of mines and their pledgeable income to obtain more leverage, has been econometrically isolated from the current transitory component of cash. It is reassuring that our basic results on cash stockpiling are robust to these various changes.

We follow the customary order in the cash-flow sensitivity literature of showing first the results with the complete sample, both OLS and IV, and then focusing on constrained firms, which constitute our main results.

5.1 Full Sample Results

Table 3 reports baseline OLS estimates of equation (1) for the full sample of firms. Columns (1) to (6) contain estimates of different specifications for the case in which the change in cash holdings is the dependent variable, while columns (7) to (12) report estimates with investment as the dependent variable. Recall that our focus will be on the estimated β coefficient, cash flow sensitivity, which

[15] Some asset price models tend to assume away potentially time-varying risk premia by assuming that traders are fully hedged in their positions and therefore face no risk. That is not always true for producers (as argued by Acharya, Lochstoer and Ramadorai (2013)), which do have meaningful unhedged exposures to the commodity. This is important because if they were fully hedged there would be no impact of surprising portion of the spot prices on cash flows. In econometric terms there would be no significant first stage, which we do have. Also, in conversations with managers in the industry we realized that as much as 80% of the production of some mines is sold in advance, but many times at prices that are defined as a spread over the London Metal Exchange (LME) price, meaning that even if the deals are closed in advance the mines have still a meaningful exposure to LME price fluctuation, consistent with our first stage results. Having said that, our approach is to recognize there might be some other factors moving over time, and we aim to control them in regressions using several time-varying covariates.

shows by how much cash holdings (or investment) change by every extra dollar received as cash flow. This dollar-by-dollar interpretation comes from the fact that, as usual, most variables are scaled by last year's total assets. In column (1), the OLS-FE estimate of the cash flow sensitivity of cash is positive but not significant. However, this sensitivity is positive and highly significant in the IV-FE estimates reported in the next five columns, in which the estimated coefficient varies between 0.29 and 0.57.[16] Thus, for each new dollar received as cash flow, around 30 to 50 cents end up as new cash holdings for the firm.

The long-term price of copper, P_t^{Long}, measured as the 27-month forward price, is negative and significant across models. Given the framework in Section 2 this result is expected since a higher future profitability not only moves the supply of funds within the firm but also generates an incentive to invest today, which reduces current cash holdings. Following Gatchev et al. (2010), we include a specification with lagged dependent variable, but this variable is not significant. Regarding the other control variables, only size seems to significantly impact cash holdings in the dynamic specification.

When looking at investment's sensitivity to cash flow, we fail to find any significant coefficient across the models. The OLS-FE estimate in column (7) is negative, whereas the IV-FE estimates in columns (8) to (11) are positive and ranging between 0.05 and 0.2. This evidence is consistent with Gatchev et al. (2010) and Dasgupta et al. (2011) that also find smaller effects of cash flow shocks on CAPEX. Regarding the control variables, we do not find many significant coefficients across specifications. For example, all the expected long-run copper price estimated coefficients are significant. In column (12), the lagged CAPEX appears positive and significant, indicating some degree of persistence in the investment dynamic, qualitatively similar to Gatchev et al. (2010). Overall, for the full sample, we find that cash holdings are to some extent associated with cash flow shocks, but this is not the case with firm investment.

Here it is worth emphasizing why one may not find a very robust effect on investment. First, the lumpy nature of investment makes it harder to find an association. Moreover, when one moves from the aggregate economy to specific firms and projects, as we do here, investment behavior is even more lumpy and therefore finding a robust association might be more difficult (see Caballero, Engel and Haltiwanger (1995), Caballero and Engel (1999), Slade (2013)). A second reason is that $CAPEX_t$ measures from the balance sheet may not reflect many activities that for economic purposes could be classified as investments, in the sense that they increase future productivity, but that for accounting purposes the firm prefers to consider as accounting costs due to the benefit of immediate 100% depreciation. Consider, for example, a tunnel that does not create any profits by itself but that connects the operations to new copper deposits in the next few years. This type of

[16] Only specification (5) is borderline insignificant at 10%. Coefficient 0.57 in specification (6) is in the context of a dynamic model that contains one lag of the left-hand side variable, therefore it is not directly comparable to the others.

"hidden investment" may be captured as smaller cash flows without appearing as $CAPEX_t$. This could be easier to measure as less cash holdings.

Before moving forward, we will make additional clarifications on our IV strategy. First, a potential endogeneity problem arises if the cash flow measure contains information on the profitability of the future investment, as suggested by Kaplan and Zingales (1997). Second, recall that as instrument of cash flow we use the difference between spot price and forward price, z_t, which after controlling for long run prices might be uncorrelated with $u_{i,t}$ in equation 1. This means that z_t does not enter directly into the investment or cash holdings decisions through any channel different from the cash flow today CF_t. Note that this would be valid after controlling for a set of additional variables such as the long-run cooper price and the interest rate. Third, in the Appendix we report some of the first-stage estimates of the IV-FE model, supporting its use.

Nonetheless, as well known in modern papers on cash flow sensitivity and remarked in Section 2, the predictions are on firms facing some relevant financial constraints or any other substantial gap between internal and external opportunity cost of resources. We focus on this next.

5.2 More Financially Restricted Firms

Prior literature suggests that financially constrained firms should act differently than financially unconstrained firms after facing a liquidity shock. For example, the theoretical model in Section 2 predicts that financially constrained firms are more sensitive to cash flow shocks. Similar predictions for investment can be found in Fazzari et al. (1987), among many others. In this section, we split the sample into restricted and unrestricted firms. We use firm size as the selection criterion.[17] In particular, we follow Almeida et al. (2004), and classify a firm as constrained if it belongs to the three lower size deciles. On the other hand, a firm is classified as unconstrained if it belongs to the three upper size deciles. Given our sample size limitations, we believe this criterion assures that each group of firms contains enough observations for estimation of the system in equations 1 and 2. For space limitations we only report the subsample of constrained firms.

Table 4 reports IV estimates for cash flow sensitivities among more constrained firms, with OLS as benchmark. Because our theoretical predictions mostly refer to the behavior of financially constrained firms, these results become the core of our paper. The first set of regressions shows that the cash flow sensitivity of cash is positive and highly significant across specifications. For example, in column (1), the OLS-FE estimate is 0.54 and significant at the 99% level. The IV-FE estimates in the following specifications indicate that around 30-60 cents of each new dollar of cash flows is stockpiled that year. These numbers are slightly above the estimates of a similar specification in Almeida et al. (2004), but for a sample of manufacturing firms. Regarding the control variables, the long-term copper price is negatively associated with the holding of cash

[17] As a robustness check, we also classify firms according their payment of dividends in the previous year. These results, reported in Section 6, remain qualitatively similar to those based on the size criterion.

Table 3. Cash Holdings and Investment Sensitivities of Cash (All Firms)

	$\Delta Cash\,Holdings_t$						$CAPEX_t$					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
CF_t	0.207	0.298**	0.332**	0.299**	0.312	0.572*	-0.262	0.204	0.221	0.0499	0.0726	0.421
	(0.195)	(0.127)	(0.135)	(0.129)	(0.200)	(0.326)	(0.170)	(0.135)	(0.176)	(0.197)	(0.493)	(0.483)
$LTCopperPrice_t$			-0.0570**	-0.115***	-0.118**	-0.131			-0.0284	-0.0317	-0.0379	-0.0187
			(0.0243)	(0.0381)	(0.0505)	(0.0880)			(0.0808)	(0.0713)	(0.128)	(0.0964)
$Size_t$				0.0140	0.0160	0.204***				-0.191	-0.187	0.121
				(0.135)	(0.142)	(0.0747)				(0.293)	(0.315)	(0.112)
$Leverage_t$				-0.435*	-0.436*	-0.294				-0.184	-0.184	0.00681
				(0.234)	(0.231)	(0.240)				(0.385)	(0.376)	(0.0594)
$Int.Rate_t$					-0.00168	-0.0216					-0.00292	-0.0412
					(0.0254)	(0.0419)					(0.0471)	(0.0548)
$\Delta Cash\,Holdings_{t-1}$						-0.0377						
						(0.0824)						
$CAPEX_{t-1}$												0.120*
												(0.0626)
Observations	189	189	189	189	189	168	189	189	189	189	189	168
R^2	0.073	0.043	0.051	0.126	0.125	0.206	0.077	-0.016	-0.018	0.016	0.014	-0.203
Number of firms	20	20	20	20	20	20	20	20	20	20	20	20
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-Test		71.51	58.00	62.42	18.42	5.668	.	71.51	58.00	62.42	18.42	4.376
Estimation Method	OLS	IV	IV	IV	IV	IV	OLS	IV	IV	IV	IV	IV

Note: The table presents panel regression estimates of $y_{it} = \gamma CF_{it} + \beta LTCopperPrice_t + \gamma X_{it} + \mu_i + \varepsilon_{it}$; where y_{it} is either $\Delta Cash\,Holdings_t$ (specifications 1 to 6) or $CAPEX_t$ (specifications 7 to 12). CF_t is cash flow in t, $LTCopperPrice$ is the 27-month forward price of copper, $Size$ is the demeaned natural logarithm of total assets, $Leverage$ is the ratio of total debt to lagged total assets, $IntRate$ is the 3-year U.S. Treasury constant maturity rate. In the IV estimation method, $CF_t$is instrumented with the spread between spot and forward copper prices. F-test is the first stage's F-test of joint significance. Robust (clustered by firm) standard errors in parenthesis: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

by these firms, similar to the full-sample estimates in the previous table and consistent with our expectations from Section 2. Firm size is positive and significant in columns (5) and (6), and firm leverage is negative and significant in columns (4) to (6). This last effect is explained by an increase in the market value of equity and not necessarily by a reduction in outstanding debt. Finally, the interest rate is negative but only significant in the specification with lagged dependent variable. This is consistent with the idea that higher opportunity cost reduced incentives for saving in cash. The IV's first-stage estimates show a strong positive correlation between our instrument and cash flows. F-test results are almost all above 10, reducing concerns about weak instruments.

For completeness, columns (7) to (12) report the cash flow sensitivity of investment for more constrained firms. As before, the left-hand side variable in specifications is firm CAPEX. The literature either finds a positive or a zero coefficient for cash flow sensitivity of investment. This is what we found in the majority of specifications, although many times not significant. The two exceptions are the OLS-FE estimate in column (7) and the IV estimate in column (9), which had an unexpected negative coefficient. Overall, even though some of the estimates are statistically significant, there is no clear pattern as is the case with cash holdings. A possible explanation for these result could be our small sample, which may interact with the abovementioned lumpiness of investment. Regarding the control variables, the expected long-term copper price is positive and highly significant across specifications. This result provides empirical support to the idea that this price is a proxy for the future investment opportunity set for these firms and that this contains information that is different from our instrumented current earnings, which deal with transitory components. A higher expected future copper price increases the expected profitability of the investment projects, and firms then increase their capital expenses. Firm size appears positive and significant in the last 3 models; and, finally, the lagged dependent variable is negative and also significant, qualitatively similar to Gatchev et al. (2010). The next version provides a battery of robustness checks for our main results.

6 Robustness Checks

In this section we will perform several stress tests on our basic results. First, we use an alternative measure of the expected long-run copper price. Second, we use as left-hand side variables the wider definitions of current assets and the change in fixed assets instead of cash holdings and CAPEX. Third, we use an alternative criterion to identify constrained and unconstrained firms, namely the payout dividend policy. Fourth, we investigate whether our main results are driven by the recent financial crisis. Fifth, we run our models in a balanced panel in order to isolate the potential effect of the behavior of young firms on our results. Finally, we add further time-varying control variables to check the robustness of our instrument. Overall, our main results remain robust to most of the perturbations we perform.

Table 4. Cash Flow Sensitivity of Cash Holdings and Investment (Restricted Firms)

	$\Delta Cash\ Holdings_t$						$CAPEX_t$					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
CF_t	0.547***	0.293*	0.476**	0.461**	0.631***	0.626***	-0.222***	0.0848	-0.0760*	0.0776	0.239**	0.189*
	(0.0894)	(0.161)	(0.209)	(0.233)	(0.138)	(0.127)	(0.0510)	(0.0542)	(0.0455)	(0.0617)	(0.101)	(0.0990)
$LTCopperPrice_t$			-0.186***	-0.180**	-0.238***	-0.254***			0.164**	0.153***	0.0978***	0.144***
			(0.0622)	(0.0901)	(0.0389)	(0.0373)			(0.0808)	(0.0176)	(0.0289)	(0.0230)
$Size_t$				0.0605	0.107**	0.0997*				0.287***	0.331***	0.370***
				(0.0652)	(0.0491)	(0.0530)				(0.0323)	(0.0395)	(0.0589)
$Leverage_t$				-0.150**	-0.144**	-0.143**				0.0291	0.0347	0.0880
				(0.0699)	(0.0691)	(0.0688)				(0.0880)	(0.0608)	(0.0694)
$Int.Rate_t$					-0.0267	-0.0351*					-0.0254	-0.0187
					(0.0354)	(0.0202)					(0.0188)	(0.0135)
$\Delta Cash\ Holdings_{t-1}$						0.136						
						(0.210)						
$CAPEX_{t-1}$												-0.249***
												(0.0909)
Observations	51	49	49	49	49	40	51	49	49	49	49	40
R-squared	0.540	0.282	0.425	0.463	0.500	0.510	0.419	0.024	0.296	0.672	0.620	0.648
Number of firms	10	8	8	8	8	7	10	8	8	8	8	7
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-Test	.	61.67	19.84	77.37	11.41	11.29	.	61.67	19.84	77.37	11.41	6.466
Estimation Method	OLS	IV	IV	IV	IV	IV	OLS	IV	IV	IV	IV	IV

Note: The table presents panel regression estimates of $y_{it} = \gamma CF_{it} + \beta LTCopperPrice_t + \gamma X_{it} + \mu_i + \varepsilon_{it}$; where y_{it} is either $\Delta Cash\ Holdings_t$ (specifications 1 to 6) or $CAPEX_t$ (specifications 7 to 12). CF_t is cash flow in t, $LTCopperPrice$ is the 27-month forward price of copper, $Size$ is the demeaned natural logarithm of total assets, $Leverage$ is the ratio of total debt to lagged total assets, and $IntRate$ is the 3-year U.S. Treasury constant maturity rate. A firm is classified as restricted if it belongs to the three lower deciles according to firm size. In the IV estimation method, $CF_t$is instrumented with the spread between spot and forward copper prices. F-test is the first stage's F-test of joint significance. Robust (clustered by firm) standard errors in parenthesis: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

6.1 Alternative Long-Run Price Expectations

While in all groups of our main regressions in Section 5 we controlled for the interest rate, some could still be concerned that a 3-year horizon could be too short to entail a long-term expectation. To address this we repeat our previous analysis replacing the 27-month forward copper price with the long-run price given by the price set by a Committee of Experts of the Chilean Ministry of Finance (see Section 4). The purpose of this committee is to provide an estimate of the price of copper in the next 10 years and use it in the estimation of the government's official budget for the next year. The committee is consulted annually and it is made up of an average of 10 experts. Information on the members of the committee and their estimates is publicly available on the Chilean Ministry of Finance's website, the source we used. In Table 5, we report the new cash flow sensitivity of cash estimates for the sample of restricted firms. These results are slightly weaker than the main results, but still supporting the fact that restricted firm's cash holdings are sensitive to cash flow shocks. The estimated coefficients are always positive across all models, although significant at usual levels only in models (1), (2) and (4). However, in the remaining columns the cash flow sensitivity of cash's p-values are not that far from being borderline significant: 0.13, 0.15 and 0.17. Perhaps because the committee's price does not represent a market price it may be a proxy with more measurement error, and dilution bias may therefore impede finding significant results. The magnitude of the IV estimates is slightly smaller than the ones obtained using the 27-month forward price (0.3 vs. 0.5, approximately). The alternative long-term price appears negative, as expected, and significant in three out of four models. The significance of firm size is lost, but leverage, as in the main results, is significant. Even though some of the results are statistically weaker, in the majority of cases we still capture the positive association between cash flow and the change in cash holdings for restricted firms.

Table 5. Cash Flow Sensitivity of Cash (Committee of Experts' Price)

	$\Delta Cash\, Holdings_t$					
	(1)	(2)	(3)	(4)	(5)	(6)
CF_t	0.547***	0.293*	0.254	0.250*	0.293	0.292
	(0.0894)	(0.161)	(0.171)	(0.143)	(0.204)	(0.215)
$LTCopperPrice_t$			-0.178**	-0.175***	-0.204	-0.222*
			(0.0768)	(0.0622)	(0.140)	(0.119)
$Size_t$				-0.0626*	-0.0504	-0.0502
				(0.0354)	(0.109)	(0.112)
$Leverage_t$				-0.213*	-0.216**	-0.202**
				(0.120)	(0.0956)	(0.0818)
$Int.Rate_t$					-0.0134	-0.0217
					(0.0908)	(0.0772)
$\Delta Cash\, Holdings_{t-1}$						0.0777
						(0.147)
Observations	51	49	40	40	40	40
R-squared	0.540	0.282	0.307	0.332	0.354	0.358
Number of firms	10	8	7	7	7	7
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
F-Test		61.67	72.82	77.66	48.34	48.84
Estimation Method	OLS	IV	IV	IV	IV	IV

Note: The table presents panel regression estimates of $y_{it} = \gamma CF_{it} + \beta LTCopperPrice_t + \gamma X_{it} + \mu_i + \varepsilon_{it}$; where y_{it} is $\Delta Cash\, Holdings_t$. CF_t is cash flow in t, $LTCopperPrice$ is the long-term price set by a Ministry of Finance's Comission of experts. $Size$ is the demeaned natural logarithm of total assets, $Leverage$ is the ratio of total debt to lagged total assets, $IntRate$ is the 3-year U.S. Treasury constant maturity rate. A firm is classified as restricted if it belongs to the three lower deciles according to firm size. In the IV estimation method, CF_t is instrumented with the spread between spot and forward copper prices. F-test is the first stage's F-test of joint significance. Robust (clustered by firm) standard errors in parenthesis: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

6.2 Broader Balance Sheet Components: Current Assets versus Cash

Cash holdings is a common proxy for a firm's liquidity. But a broader liquidity measure may be of interest in the context of MNCs. For example, MNCs may strategically decide reporting less cash in their balance sheet but increase accounts receivable with their headquarters as a way to repatriate liquidity. In this subsection we investigate the robustness of our results to the use as left-hand side variables of current assets and the change in fixed assets instead of cash holdings and CAPEX. Recall that current assets are composed of cash, accounts receivable and others current assets; while CAPEX includes both changes in fixed assets and depreciation. Table 6, reports our new estimates. Columns (1) to (6) report changes in current assets as the dependent variable, while columns (7) to (12) report the models for the change in fixed assets. The cash flow sensitivity of cash holdings is still positive and strongly significant for all specifications. The estimated coefficients range between 0.35 and 0.90. A permanent profitability shock, measured as the long-run copper price, is negative and mostly significant. Size and the interest rate also appear as important determinants in the specification with lagged dependent variable. Regarding the change in fixed assets regressions, as with CAPEX in Section 5, we fail to find a robust pattern across specifcations. The expected long-term copper price is positive and significant, as in the main results. Size is positive and significant, whereas in the last model, leverage and the lagged dependent variable also appear significant. Overall, our main message remains: for financially restricted firms, current assets are strongly associated with cash flow shocks.

6.3 Alternative Measure of Financial Constraints

Following Almeida et al. (2004), among others, we also use an alternative criterion for classifying firms as financially constrained: a firm is financially unrestricted if it paid dividends this year, and restricted otherwise. Table 7 reports estimates for restricted firms. Note that, according to this criterion, more firms are classified as restricted, and as a consequence the number of observations almost doubled. Nonetheless, the results are quite similar to those reported using size as classification criterion. The cash flow sensitivity of cash is positive across models, and significant in four out of six models. The point estimates for models without lags range between 0.4 and 0.8. It is reassuring again that in this sample the future price is negative and mostly significant. The F-tests are around and above 10 in most of the specifications, reducing concerns about weakness.[18] The results for investment sensitivity differ to some extent from the baseline results. Now, the cash flow sensitivity parameter is not significant in any model. Indeed, none of the remaining control variables appear significant, with the exceptions of the long-run copper price and the lagged dependent variable in column (12). Again, we confirm that using an alternative firm classication criterion our main results in Section 5 still hold.

6.4 Great Recession

The 2008-2009 financial crisis and recession spread around the globe, also impacting our sample of commodity MNCs: the price of copper dropped by around 60% during the crisis period. In this subsection, we investigate the extent to which our results could be driven by the effects of the crisis on these companies. In particular, we address this issue by incorporating a dummy variable that takes the value of one during 2008 and 2009, and zero otherwise. Our results are reported in Table 8. We confirm the robustness of our baseline results. The cash flow sensitivity of cash holdings is highly significant in all but the model with lagged dependent variable, which

[18] The exception is the model with lagged dependent variable where the F-test is 5.1, but this is not directly interpretable in the same way, and the point estimate for cash flow sensitivity of cash is 1.2. They are significantly different from zero but with very wide confidence intervals that are not different from previous models in Section 5.

Table 6. Cash Flow Sensitivity of Current and Fixed Assets

	$\Delta Current\ Assets_t$						$\Delta Fixed\ Assets_t$					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
CF_t	0.556***	0.358**	0.484**	0.490**	0.908***	0.747***	-0.436***	0.0994	-0.159**	-0.0255	-0.0780	0.158
	(0.0774)	(0.157)	(0.206)	(0.219)	(0.234)	(0.203)	(0.0775)	(0.0902)	(0.0709)	(0.0832)	(0.147)	(0.146)
$LTCopperPrice_t$			-0.128**	-0.124	-0.267***	-0.253***			0.263***	0.259***	0.277***	0.289***
			(0.0650)	(0.0958)	(0.0577)	(0.0550)			(0.0949)	(0.0394)	(0.0519)	(0.0324)
$Size_t$				0.0821*	0.196***	0.148**				0.328***	0.314***	0.492***
				(0.0448)	(0.0722)	(0.0640)				(0.0709)	(0.0817)	(0.0853)
$Leverage_t$				-0.117	-0.103	-0.127				-0.106	-0.108	-0.111*
				(0.0896)	(0.103)	(0.0800)				(0.0703)	(0.0746)	(0.0581)
$Int.Rate_t$					-0.0659	-0.0523*					0.00827	-0.0349
					(0.0449)	(0.0285)					(0.0302)	(0.0342)
$\Delta Cash\ Holdings_{t-1}$						0.145						
						(0.211)						
$CAPEX_{t-1}$												-0.362***
												(0.112)
Observations	51	49	49	49	49	40	51	49	49	49	49	40
R-squared	0.564	0.377	0.451	0.489	0.522	0.553	0.645	0.030	0.332	0.732	0.711	0.793
Number of firms	10	8	8	8	8	7	10	8	8	8	8	7
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-Test	.	61.67	19.84	77.37	11.41	10.70	.	61.67	19.84	77.37	11.41	7.300
Estimation Method	OLS	IV	IV	IV	IV	IV		OLS	IV	IV	IV	IV

Note: The table presents panel regression estimates of $y_{it} = \gamma CF_{it} + \beta LTCopperPrice_t + \gamma X_{it} + \mu_i + \varepsilon_{it}$; where y_{it} is either $\Delta Current\ Assets_t$ (specifications 1 to 6) or $\Delta Fixed\ Assets_t$ (specifications 7 to 12). CF_t is cash flow in t, $LTCopperPrice$ is 27-month forward price of copper, $Size$ is the demeaned natural logarithm of total assets, $Leverage$ is the ratio of total debt to lagged total assets, $IntRate$ is the 3-year U.S. Treasury constant maturity rate. In the IV estimation method, $CF_t$is instrumented with the spread between spot and forward copper prices. F-test is the first stage's F-test of joint significance. Robust (clustered by firm) standard errors in parenthesis: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7. Alternative Measure of Financially Constrained Firms (Dividends)

	$\Delta Cash\,Holdings_t$						$CAPEX_t$					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
CF_t	0.255	0.733**	0.864**	0.591**	0.357	1.219***	-0.661	0.726	0.962	0.602	-0.300	-0.403
	(0.442)	(0.344)	(0.372)	(0.282)	(0.552)	(0.459)	(0.421)	(0.463)	(0.751)	(0.876)	(1.211)	(0.417)
$LTCopperPrice_t$			-0.101	-0.239**	-0.203	-0.238**			-0.181	-0.150	-0.0107	0.118**
			(0.0777)	(0.115)	(0.130)	(0.109)			(0.236)	(0.172)	(0.172)	(0.0524)
$Size_t$				-0.00337	-0.0360	0.370**				-0.233	-0.359	-0.104
				(0.217)	(0.245)	(0.154)				(0.515)	(0.565)	(0.0992)
$Leverage_t$				-0.637*	-0.675*	-0.232				-0.194	-0.337	-0.0954
				(0.379)	(0.401)	(0.474)				(0.759)	(0.785)	(0.201)
$Int.Rate_t$					0.0215	-0.0282					0.0831	0.0507
					(0.0393)	(0.0348)					(0.0654)	(0.0340)
$\Delta Cash\,Holdings_{t-1}$						0.0371						
						(0.0515)						
$CAPEX_{t-1}$												0.0688**
												(0.0347)
Observations	90	88	88	88	88	72	90	88	88	88	88	72
R-squared	0.129	0.033	0.027	0.160	0.190	0.220	0.223	-0.058	-0.076	-0.017	0.080	0.384
Number of firms	17	15	15	15	15	15	17	15	15	15	15	15
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-Test	.	20.23	12.10	12.51	9.542	5.158	.	20.23	12.10	12.51	9.542	3.453
Estimation Method	OLS	IV	IV	IV	IV	IV	OLS	IV	IV	IV	IV	IV

Note: The table presents panel regression estimates of $y_{it} = \gamma CF_{it} + \beta LTCopperPrice_t + \gamma X_{it} + \mu_i + \varepsilon_{it}$; where y_{it} is either $\Delta Cash\,Holdings_t$ (specifications 1 to 6) or $CAPEX_t$ (specifications 7 to 12). CF_t is cash flow in t, $LTCopperPrice$ is 27-month forward price of copper, $Size$ is the demeaned natural logarithm of total assets, $Leverage$ is the ratio of total debt to lagged total assets, $IntRate$ is the 3-year U.S. Treasury constant maturity rate. A firm is classified as restricted if it did not pay dividends in the previous year. In the IV estimation method, $CF_t$is instrumented with the spread between spot and forward copper prices. F-test is the first stage's F-test of joint significance. Robust (clustered by firm) standard errors in parenthesis: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

is not directly comparable to the others. Long-run copper price is negative and significant. An alternative approach to including the 2008-2009 dummy variable is to restrict our sample period to 2000-2007 in order to exclude the crisis period. Results not reported here show that following this procedure produce similar results to those obtained by including the crisis dummy, although we prefer the former due to sample size, which is already small. We conclude that our main results are robust to controlling for the 2008-2009 crisis.

Table 8. Cash Flow Sensitivity of Cash (Dummy 2008-2009)

	$\Delta Cash\,Holdings_t$					
	(1)	(2)	(3)	(4)	(5)	(6)
CF_t	0.547***	0.258*	0.482**	0.436**	0.667**	1.123
	(0.0894)	(0.136)	(0.194)	(0.182)	(0.312)	(0.849)
$LTCopperPrice_t$			-0.191***	-0.165***	-0.256*	-0.488
			(0.0516)	(0.0559)	(0.131)	(0.332)
$Size_t$				0.0533	0.117*	0.243
				(0.0533)	(0.0702)	(0.212)
$Leverage_t$				-0.154*	-0.139	-0.0662
				(0.0790)	(0.0907)	(0.178)
$Int.Rate_t$					-0.0283	-0.0866
					(0.0469)	(0.0921)
$\Delta Cash\,Holdings_{t-1}$						0.367
						(0.237)
$Dummy2008-09$	0.177***	-0.134	0.00816	-0.0258	0.0266	0.252
	(0.0244)	(0.0966)	(0.0319)	(0.0685)	(0.168)	(0.324)
Observations	51	49	49	49	49	40
R-squared	0.540	0.306	0.426	0.455	0.503	0.488
Number of firms	10	8	8	8	8	7
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
F-Test	.	54.90	26.10	31.88	4.492	2.689
Estimation Method	OLS	IV	IV	IV	IV	IV

Note: The table presents panel regression estimates of $y_{it} = \gamma CF_{it} + \beta LTCopperPrice_t + \gamma X_{it} + \mu_i + \varepsilon_{it}$; where y_{it} is $\Delta Cash\,Holdings_t$. CF_t is cash flow in t, $LTCopperPrice$ is 27-month forward price of copper, $Size$ is the demeaned natural logarithm of total assets, $Leverage$ is the ratio of total debt to lagged total assets, $IntRate$ is the 3-year U.S. Treasury constant maturity rate and $Dummy2008-09$ is a dummy variable that takes the value of 1 in years 2008 and 2009 and 0 otherwise. A firm is classified as restricted if belong to the three lower deciles according to firm's size. In the IV estimation method, $CF_t$is instrumented with the spread between spot and forward copper prices. F-test is the first stage's F-test of joint significance. Robust (clustered by firm) standard errors in parenthesis: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

6.5 Project Life Cycle

A potential concern with our basic set of results is that the mines in our sample may be at different stages of development. Some projects may be starting, while others are at advanced stages, and the composition effect may be generating our estimated cash flow sensitivities. To address this issue, we re-run our baseline regressions with a balanced panel in order to work with a set of more mature companies. In practice, we use mines reporting total assets during the full sample period: 2001-2012. Table 9 shows that the robustness check results are stronger and aligned with baseline results, with the cash flow sensitivity of cash being positive and significant across models. The point estimates varies between 0.29 and 0.60. The control variables tend also to appear more significant in these regressions than in the baseline regressions. In sum, our baseline results become stronger if we restrict our sample to a constant set of companies.

Table 9. Cash Flow Sensitivity of Cash (Project Cycle)

	$\Delta Cash\,Holdings_t$					
	(1)	(2)	(3)	(4)	(5)	(6)
CF_t	0.547***	0.290*	0.460**	0.448**	0.579***	0.604***
	(0.0894)	(0.161)	(0.207)	(0.226)	(0.120)	(0.127)
$LTCopperPrice_t$			-0.183***	-0.177**	-0.223***	-0.252***
			(0.0629)	(0.0888)	(0.0333)	(0.0367)
$Size_t$				0.0566	0.0942**	0.0951*
				(0.0628)	(0.0394)	(0.0502)
$Leverage_t$				-0.147**	-0.139*	-0.133**
				(0.0703)	(0.0722)	(0.0646)
$Int.Rate_t$					-0.0218	-0.0353*
					(0.0377)	(0.0202)
$\Delta Cash\,Holdings_{t-1}$						0.144
						(0.208)
Observations	51	43	43	43	43	37
R-squared	0.540	0.281	0.426	0.461	0.500	0.513
Number of firms	10	6	6	6	6	6
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
F-Test	.	82.43	23.85	172.3	32.25	18.21
Estimation Method	OLS	IV	IV	IV	IV	IV

Note: The table presents panel regression estimates of $y_{it} = \gamma CF_{it} + \beta LTCopperPrice_t + \gamma X_{it} + \mu_i + \varepsilon_{it}$; where y_{it} is $\Delta Cash\,Holdings_t$. CF_t is cash flow in t, $LTCopperPrice$ is 27-month forward price of copper, $Size$ is the demeaned natural logarithm of total assets, $Leverage$ is the ratio of total debt to lagged total assets and $IntRate$ is the 3-year U.S. Treasury constant maturity rate. A firm is classified as restricted if belong to the three lower deciles according to firm' size. In the IV estimation method, $CF_t$is instrumented with the spread between spot and forward copper prices. The sample is restricted to those firms reporting total assets during the full sample period. F-test is the first stage's F-test of joint significance. Robust (clustered by firm) standard errors in parenthesis: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

6.6 Additional Controls and Results

Another potential concern with our basic specification is that any time-varying effect is only captured by the long-run copper price and the interest rate. If any other important time-varying variable is omitted, our results may be biased. To mitigate this concern we include two additional control variables: China's GDP growth rate and a global commodity price index, taken from the IMF's International Finance Statistics and the IMF's Primary Commodity Prices, respectively. In particular, we use the commodity metal price index as our global commodity index. In Table 10 we report our results. The estimates are not particularly affected by the inclusion of these additional control variables. The cash flow sensitivity of cash estimates are positive and significant across models, except for the model with lagged dependent variable, which again, cannot be directly compared. The estimated coefficient ranges between 0.5 and 0.7, slightly above the baseline estimates. Overall, our baseline results are robust to the inclusion of additional time-varying control variables.

Table 10. Cash Flow Sensitivity of Cash (Other Controls)

	$\Delta Cash\,Holdings_t$					
	(1)	(2)	(3)	(4)	(5)	(6)
CF_t	0.547***	0.577***	0.771***	0.714***	0.630**	0.241
	(0.0894)	(0.122)	(0.214)	(0.252)	(0.265)	(0.293)
$LTCopperPrice_t$			-0.405***	-0.394***	-0.377***	-0.321**
			(0.0941)	(0.126)	(0.100)	(0.131)
$Size_t$				0.113	0.0893	-0.0325
				(0.0808)	(0.0647)	(0.113)
$Leverage_t$				-0.156*	-0.160*	-0.142
				(0.0842)	(0.0900)	(0.123)
$Int.Rate_t$					0.0164	0.0886
					(0.0490)	(0.0806)
$\Delta Cash\,Holdings_{t-1}$						0.126
						(0.188)
$GDPChina_t$	-0.0350**	-0.0341*	-0.0529*	-0.0422	-0.0457*	-0.0739*
	(0.0137)	(0.0174)	(0.0285)	(0.0291)	(0.0263)	(0.0413)
$Commodity\,Index_t$	-0.00255***	-0.00124***	0.00199*	0.00209*	0.00227	0.00287
	(0.000258)	(0.000338)	(0.00109)	(0.00115)	(0.00171)	(0.00222)
Observations	51	49	49	49	49	40
R-squared	0.540	0.349	0.466	0.552	0.554	0.438
Number of firms	10	8	8	8	8	7
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
F-Test		6.403	3.450	9.389	7.676	6.132
Estimation Method	OLS	IV	IV	IV	IV	IV

Note: The table presents panel regression estimates of $y_{it} = \gamma CF_{it} + \beta LTCopperPrice_t + \gamma X_{it} + \mu_i + \varepsilon_{it}$; where y_{it} is $\Delta Cash\,Holdings_t$. CF_t is cash flow in t, $LTCopperPrice$ is 27-month forward price of copper, $Size$ is the demeaned natural logarithm of total assets, $Leverage$ is the ratio of total debt to lagged total assets, $IntRate$ is the 3-year U.S. Treasury constant maturity rate, $GDPChina_t$ is China's GDP growth rate and $Commodity\,Index_t$ is the IFS's global (metal) commodity index. A firm is classified as restricted if it belongs to the three lower deciles according to firm' size. In the IV estimation method, $CF_t$is instrumented with the spread between spot and forward copper prices. F-test is the first stage's F-test of joint significance. Robust (clustered by firm) standard errors in parenthesis: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

7 Concluding Remarks

This paper explores how branches of commodity multinationals save liquidity. In particular, we built a sample of non-publicly traded copper mines located in Chile and Peru between 2001-2012. As identification strategy for investment and cash responses to earnings we benefit from the fact that investment decisions depend on expectations of the long-run price of copper, while cash flows depend on the spot price. Our multiple specifications and robustness checks show that cash stockpiling is one important use of cash flow. In our preferred empirical models, out of an extra dollar in cash between 20 and 50 cents end up as extra cash, especially among financially constrained firms. Overall, during this commodity boom cash holdings tripled their share of assets. In sum, our results support financial theories noting the salience of cash as buffer stock for liquidity (e.g., Almeida et al. (2004)), especially in contexts where projects have time to build and also when repatriation and corporate taxes segment the different cash stockpiles of multinationals' branches.

From a policy perspective our paper suggests that mining multinationals in a country are a pool of complex liquidity management, especially when access to external finance of these companies is relatively weaker, either because of market conditions or agency problems within the multinational.

Changes in the taxation of profits, for example moving from a cash basis to an accrual basis as recently done in Chile, may impact savings and stockpiling decisions of foreign corporations and the Balance of Payments. A similar change could happen with any other determinants of the costs and benefits of holding cash, including the massive drop of copper prices during late 2014 and early 2015. Last but not least, we remark that, although reinvestment of multinationals' earning is considered a Foreign Direct Investment in the Balance of Payments, here we show that at least in the short run a significant share of it does not constitute new investment in the National Accounts, since it remains in cash rather than fixed assets. A recent paper of the authors Hansen and Wagner (2015) studies the macroeconomic implications of this phenomenon.

References

Acharya, V. V., L. A. Lochstoer, and T. Ramadorai. 2013. "Limits to Arbitrage and Hedging: Evidence From Commodity Markets." *Journal of Financial Economics*. 109(2): 441–465.

Almeida, H., M. Campello, I. Cunha, and M. S. Weisbach. 2013. "Corporate Liquidity Management: A Conceptual Framework and Survey." NBER Working Paper 19502. Cambridge, MA, United States: National Bureau of Economic Research.

Almeida, H., M. Campello, and M. S. Weisbach. 2004. "The Cash Flow Sensitivity of Cash." *The Journal of Finance*. 59(4): 1777–1804.

Andrén, N. and H. Jankensgård. 2015. "Wall of Cash: The Investment-cash Flow Sensitivity when Capital Becomes Abundant." *Journal of Banking & Finance*. 50 204–213.

Bates, T. W., K. M. Kahle, and R. M. Stulz. 2009. "Why Do Us Firms Hold so Much More Cash than They Used To?" *The Journal of Finance*. 64(5): 1985–2021.

Blanchard, O. J., F. Lopez-de Silanes, and A. Shleifer. 1994. "What Do Firms Do with Cash Windfalls?" *Journal of Financial Economics*. 36(3): 337–360.

Burgin, L. B. 1974. "Time Required in Developing Selected Arizona Copper Mines." *Denver, CO: U.S. Department of the Interior, Bureau of Mines, IC 8702, 1974 Jan; :1-144*.

Caballero, R. J., E. M. R. A. Engel, and J. C. Haltiwanger. 1995. "Plant-Level Adjustment and Aggregate Investment Dynamics." *Brookings Papers on Economic Activity*. 26(2): 1–54.

Caballero, R. J. and E. M. Engel. 1999. "Explaining Investment Dynamics in US Manufacturing: a Generalized (S, s) Approach." *Econometrica*. 67(4): 783–826.

Campbell, J. L., D. S. Dhaliwal, L. K. Krull, and C. M. Schwab. 2014. "US Multinational Corporations' Foreign Cash Holdings: an Empirical Estimate and its Valuation Consequences." *Available at SSRN 2277804*.

Campello, M., E. Giambona, J. R. Graham, and C. R. Harvey. 2011. "Liquidity Management and Corporate Investment During a Financial Crisis." *Review of Financial Studies*. 24(6): 1944–1979.

Campello, M., J. R. Graham, and C. R. Harvey. 2010. "The Real Effects of Financial Constraints: Evidence From a Financial Crisis." *Journal of Financial Economics*. 97(3): 470–487.

Carter, D. A., D. A. Rogers, and B. J. Simkins. 2006. "Does Hedging Affect Firm Value? Evidence from the Us Airline Industry." *Financial Management*. 35(1): 53–86.

Casassus, J. and P. Collin-Dufresne. 2005. "Stochastic Convenience Yield Implied from Commodity Futures and Interest Rates." *The Journal of Finance*. 60(5): 2283–2331.

Cashin, P., L. F. Céspedes, and R. Sahay. 2004. "Commodity Currencies and the Real Exchange Rate." *Journal of Development Economics*. 75(1): 239–268.

Chen, Y.-c. and K. Rogoff. 2003. "Commodity Currencies." *Journal of International Economics*. 60(1): 133–160.

Chen, Y.-C., K. S. Rogoff, and B. Rossi. 2010. "Can Exchange Rates Forecast Commodity Prices?." *The Quarterly Journal of Economics*. 125(3): 1145–1194.

Cortazar, G. and J. Casassus. 1998. "Optimal Timing of a Mine Expansion: Implementing a Real Options Model." *The Quarterly Review of Economics and Finance*. 38(3): 755–769.

Cortazar, G., E. S. Schwartz, and J. Casassus. 2001. "Optimal Exploration Investments Under Price and Geological-technical Uncertainty: a Real Options Model." *R&D Management*. 31(2): 181–189.

Dasgupta, S., T. H. Noe, and Z. Wang. 2011. "Where Did All the Dollars Go? The Effect of Cash Flows on Capital and Asset Structure." *Journal of Financial and Quantitative Analysis*. 46(05): 1259–1294.

Fazzari, S., R. G. Hubbard, and B. C. Petersen. 1987. "Financing Constraints and Corporate Investment." NBER Working Paper 2387. Cambridge, Mass., United States: National Bureau of Economic Research.

Foley, F., J. Hartzell, S. Titman, and G. Twite. 2007. "Why Do Firms Hold so much Cash? A Tax-based Explanation." *Journal of Financial Economics*. 86(3): 579–607.

Gatchev, V. A., T. Pulvino, and V. Tarhan. 2010. "The Interdependent and Intertemporal Nature of Financial Decisions: An Application to Cash Flow Sensitivities." *The Journal of Finance*. 65(2): 725–763.

Hansen, E. and R. Wagner. 2015. "Foreign Direct Investment as Capital Flow. Multinationals' Saving and Macro-vulnerability." *mimeo*.

Horioka, C. Y. and A. Terada-Hagiwara. 2013. "Why Asian Firms Hold Cash." NBER Working Paper 19688. Cambridge, Mass., United States: National Bureau of Economic Research.

Hovakimian, G. 2009. "Determinants of Investment Cash Flow Sensitivity." *Financial Management*. 38(1): 161–183.

Imbens, G. W. and J. D. Angrist. 1994. "Identification and Estimation of Local Average Treatment Effects." *Econometrica: Journal of the Econometric Society*. 62(2): 467–475.

Kaplan, S. N. and L. Zingales. 1997. "Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints?" *The Quarterly Journal of Economics*.

Lamont, O. 1997. "Cash Flow and Investment: Evidence from Internal Capital Markets." *The Journal of Finance*. 52(1): 83–109.

Radetzki, M. and C. Van Duyne. 1984. "The Response of Mining Investment to a Decline in Economic Growth: The Case of Copper in the 1970s." *Journal of Development Economics*. 15(1): 19–45.

Rajan, R. and L. Zingales. 1998. "Financial Dependence and Growth." *The American Economic Review*. 88(3): 559–586.

Rauh, J. D. 2006. "Investment and Financing Constraints: Evidence from the Funding of Corporate

Pension Plans." *The Journal of Finance*. 61(1): 33–71.

Slade, M. E. 2013. "Investment and Uncertainty With Time to Build: Evidence from US Copper Mining."

Tufano, P. 1996. "Who Manages Risk? An Empirical Examination of Risk Management Practices In The Gold Mining Industry." *The Journal of Finance*. 51(4): 1097–1137.

UNCTAD. 2013. *Global Investment Report*.

A Appendix: Supporting Data and Figures

1 Detail of Instrumental Variables First Stage Regression for Main Specifications

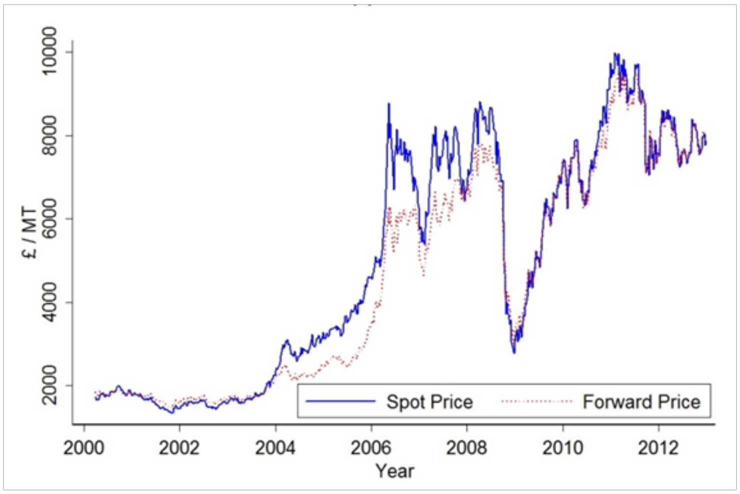
Appendix Table 11. IVFE's First-Stage Regression

	$Cash\,Flow$	
	All Firms	Restricted Firms
	(1)	(2)
$Spread_t$	0.0004 ***	0.0004**
	(0.0001)	(0.0001)
$LTCopperPrice_t$	0.1187 **	0.1766*
	(0.0521)	(0.0907)
$Size_t$	-0.1788 ***	-0.2397
	(0.0514)	(0.1577)
$Leverage_t$	0.0357	0.0418
	0.1484	0.1829
$Int.Rate_t$	0.0042	0.0003
	(0.0236)	(0.0321)
Observations	189	49
R-squared	0.624	0.703
Number of folio	20	8
Firm FE	Yes	Yes
F-Test	18.42	11.41

Note: Regressions show estimations of panel regression $CF_{it} = \gamma spread_t + \beta X_{it} + \mu_i + \varepsilon_{it}$; where CF_{it} is the Cash Flow in t, spred is the difference between the 27-month forward copper price and the spot copper price, $LTCopperPrice$ is 27-month forward price of copper, $Size$ is the demeaned natural logarithm of total assets, $Leverage$ is the ratio of total debt to lagged total assets, $IntRate$ is the 3-year U.S. Treasury constant maturity rate. The sample is restricted to those firms in the three lower deciles when sorted by firm size. F-test is the first stage's F-test of joint significance. Robust (clustered by firm) standard errors in parenthesis: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

2 Copper Prices over Our Sample Period

Appendix Figure 2. Spot and 27-month Forward Copper Prices



Appendix Figure 3. Spread between Spot and Forward Copper Prices