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Cash conversion cycle and value-enhancing operations: Theory and evidence for a free lunch

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ABSTRACT

The empirical literature shows that firms overinvest in working capital and that these investments are economically inefficient. We decompose working capital investments in the cash conversion cycle and growth effects in the presence of x-inefficiency. We predict that reductions in the cash conversion cycle should increase shareholder value. Direct evidence follows from a case study of a listed company in Brazil, MRV. Changes in operations reduced CCC from 508 days in 2012 to 351 days in 2015, decreasing working capital requirements by US $1.02 billion. Indirect evidence comes from (1) a synthetic control comparing MRV's free cash flow to equity to its direct and distant competitors; (2) an event study of share prices, and (3) a dynamic cash flow estimation using Tobin's Q as the dependent variable. Outcomes suggest that CCC management, controlling for effects on operating margins, result in higher stock prices and profitability, and increased cash flow. The theoretical framework and results reconcile the literature and provide a rationale for the overinvestment and the inefficiency of working capital investments.

1. Introduction

There are three well-documented and persistent empirical results in the management literature: firms overinvest in working capital; these investments usually do not cover the cost of capital; and reducing the cash conversion, or cash-to-cash, cycle (CCC or C2C) increases profitability. There are two possible reasons: first, there is no general model that optimizes working capital investments; and second, x-inefficiency, the difference between theoretical predictions of what managers should do and what they actually do, may be rampant. Improving CCC management and returns on working capital investments require streamlining operations, which are constrained by cash flow and operating margin considerations.

The relationship between operating working capital (OWC), CCC, and profitability is not linear (Aktas et al., 2015). On the one hand, higher OWC through longer sales terms, higher inventories, or short-term payables may increase sales. On the other hand, any investment in working capital generates a cost of capital. While there is consensus that companies have an optimal amount of working capital, which led to a long tradition of studying its optimization (Sagan, 1955; Merville and Tavis, 1973; Sartoris and Spruill, 1974; Gardner et al., 1986), no canonical model optimizes firm value constrained by the dynamics of OWC, the part of working capital tied up in operations and the variable of interest as a driver of profitability. To the best of our knowledge, no

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study (1) defines the relationship between operating working capital (OWC) and CCC or (2) provides direct and indirect evidence of how CCC management improves profitability in the presence of x-inefficiency.

Despite this gap in the literature, our knowledge of the impact of OWC and the CCC has grown steadily. Rafuse (1996) highlights the need to refocus on working capital management (WCM), especially for cash-starved companies such as small and medium-sized enterprises (SMEs), and shows that not concentrating on the CCC and its relation with working capital can be financially wasteful and leave plenty of money on the table. Kieschnick et al. (2013) were the first to examine the relationship between WCM and shareholder wealth, highlighting the drivers of working capital investment for US corporations from 1990 to 2006. Aktas et al. (2015) and Almeida and Eid (2014) provide indirect evidence of how corporate investment is an important channel through which efficient WCM translates into superior firm performance, and Ben-Nasr (2016) highlights the importance of ownership type for the value of investment in working capital. We complement these results by expanding on this transmission channel and providing direct evidence that operational efficiency is the main mechanism by which minimizing the CCC drives value creation.

CCC management is especially relevant in the presence of financial constraints (Belghitar and Khan, 2013; Pal et al., 2014) or for companies with significant growth opportunities (Campello et al., 2011). For example, working capital requirements hinder firm growth (e.g., Albuquerque and Hopenhayn, 2004; Raddatz, 2006). Since working capital is a substitute for cash (Opler et al., 1999) and competes with fixed investments for a limited pool of financing (Fazzari and Petersen, 1993), SMEs and companies in emerging markets that face borrowing constraints should make CCC management a particularly important component of their value creation strategies.

Another persistent result is that working capital investments generate lower profits than either cash or investments in hard assets. For Japanese firms, there is a strong negative relationship between the length of the firm's CCC and profitability (Nobanee et al., 2011). Yazdanfar and Öhman (2014) find a similar result for Swedish companies. For small firms in the US, there is also evidence that firms with more efficient CCCs are more liquid, require less financing, and are more profitable, while the owners/managers of small firms may be reactive (Howorth and Westhead, 2003; Ebben and Johnson, 2011). Moreover, Claessens et al. (2012) show that during the financial crisis, disruptions to the supply of working capital reduced firm-level sales. Similarly, Tong and Wei (2011) find that in industries with large working capital requirements, stock prices fall more than in other industries. Further, Anagnostopoulou (2012) finds interesting differences in the effects of working capital across public and private firms. She shows that private firms have significantly lower CCCs than their public counterparts, that the traditional determinants of the cycle significantly differ between the two groups, and that the CCC has a relatively strong (negative) impact on operating profitability for private firms compared with for public firms.

Kieschnick et al. (2013) provide the most comprehensive study of the relationship between WCM and shareholder wealth. For a sample of US companies, they find that every incremental dollar invested in net OWC is worth less than an incremental dollar held in cash, and that a firm's future sales expectations, debt load, financial constraints, and bankruptcy risk help determine working capital investments. In addition, Kieschnick et al. (2013)) show that firms overinvest in working capital and that industry practices, firm size, future firm-level sales growth, the proportion of outsider directors on the board, executive compensation, and CEO share ownership significantly influence the efficiency of a company's WCM. Almeida and Eid (2014) quantify the impact of investments in working capital and firm value for public companies in Brazil, corroborating Kieschnick et al.'s (2013) findings. Moreover, they find that increasing the level of working capital at the beginning of a fiscal year reduces company value. Finally, better corporate governance can improve WCM (Gill and Biger, 2013).

The extant results indicate that merely investing in working capital does not yield significant profits, but that managing the CCC improves profitability. Hill et al. (2010) explore the dynamics of this relationship and show that net OWC captures multiple dimensions of firms' adjustments to operating and financial conditions and that variables such as sales growth, uncertainty of sales, costly external financing, and financial distress encourage firms from pursuing more aggressive working capital strategies. They divide companies into two groups: (i) firms with greater internal financing capacity and superior capital market access that employ more conservative working capital policies and (ii) financially constrained or high-growth firms that employ more aggressive strategies. Ultimately, cash-starved firms should free cash tied up in operations more aggressively. Ding et al. (2013) corroborate this conclusion with findings that good WCM may help Chinese firms alleviate the effects of financing constraints on fixed investment.

We reconcile these works by exploring the direct link between CCC, working capital, sales, and profits. The present theoretical contribution is a decomposition of working capital growth into revenue and CCC effects, assuming a constant operating margin on a stylized mature firm with no cash holdings. We develop a formal hypothesis linking CCC reductions with higher enterprise value. For empirical support, we rely on a case study of MRV, a listed company in Brazil. We select MRV because it implemented a specific project to shorten its CCC. In addition, the company's business model engenders a relatively stable operating margin, an ideal situation under which to test our main hypothesis; and we can establish external validity by comparing it with its peers (i.e., all listed companies with available financial information and the same constraints as MRV).

The empirical strategy is fourfold: one direct and three indirect. The first shows the results of the CCC program at MRV; operational efficiency leads to a decrease in the CCC without affecting sales or the operating margin. We then use a synthetic control methodology to estimate the project's impact on MRV's free cash flow to equity. For that purpose, we build two synthetic MRVs for direct and distant competitors. We then use an event study to show the link between operational efficiency and share prices, complementing it with a dynamic cash flow estimation that ties Tobin's Q to changes in the CCC. Methodologically, we show that through careful identification strategies that combine more than one method researchers can unearth important relationships by

using cases studies that relate operations management to financial indicators. Our results are robust, with the direct evidence indicating that the CCC reduction project generated over US$1 billion in free cash flow to equity (FCFE) in the three years from 2012 to 2015. This amount was previously tied up in inefficient operations. The indirect evidence corroborates the increase in FCFE due to structural reductions in CCC controlling for investment patterns in the industry. It also points to higher stock prices and profitability.

The remainder of the paper proceeds as follows. Section 2 presents the theoretical framework in which we decompose the management of working capital into two categories: a value-creating category based on the revenue effect and a value-destroying one related to increases in the CCC. We present the MRV case study and direct evidence of the impact of its CCC management project in Section 3. Section 4 provides indirect evidence using three methodological approaches: synthetic control, event study, and dynamic cash flow management estimation. Section 5 concludes.

2. Cash conversion cycle and operational working capital

There is a fundamental tradeoff in CCC optimization: lengthening it might improve margin and sales, while shortening it could lead to higher costs and lost revenue. Maximizing shareholder value depends on minimizing the CCC constrained by operating margins and sales. Here, we establish a relationship between the CCC, OWC, and sales that relies on two assumptions: a constant operating margin and no cash holdings for a single product mature company. We make no general claims but illustrate that, given x-inefficiency, the present framework is ideal to demonstrate the link between the CCC and loss-making working capital investments. Usually, cash conversion cycle or cash-to-cash cycle is defined as

$$\mathrm{CCC} = DIO + DSO - DPO$$

where *DIO* is days of inventory outstanding, or average inventory divided by the costs of goods and services sold (*COGS*); *DSO* is days of sales outstanding, or average accounts receivables divided by daily revenue; and *DPO* is days of payment outstanding, which is average accounts payable divided by *COGS*. If the operating margin (*revenue* – *COGS*) is constant, we can rewrite *DIO* and *DPO*, without loss of generality, as

$$DIO = \frac{\text{Inventories}}{\text{Daily Revenue}} \text{ and } DPO = \frac{\text{Accounts Payable}}{\text{Daily Revenue}} \tag{1}$$

We can then rewrite the CCC as

$$\mathrm{CCC} = DIO + DSO - DPO = \frac{\text{Inventories} + \text{Receivables} - \text{Accounts Payable}}{\text{Daily revenue}} \tag{2}$$

If we define OWC as the capital tied up in operations (inventories + receivables – accounts payable), then

$$\mathrm{CCC} = \frac{\text{OWC}}{\text{Daily Revenue}^{*}365} = \frac{\text{OWC}}{\text{Annual Revenue}} \tag{3}$$

The firm that best fits Eq. (3) is a mature single-product company. The ideal company would constantly purchase inputs, transform them into final products, and sell them, with a constant operating margin and predictable deadlines for suppliers and consumers. Here, there are no cash holdings in OWC because we assume a production process that is stable over time, as shown in Fig. 1.

Variations in OWC come from changes in the CCC or increased sales and a combined effect that occurs only if both variables change simultaneously (assuming daily revenue *365 as annual revenue):

$$\Delta\mathrm{OWC} = \mathrm{CCC}^{*}\Delta\mathrm{Revenue} + \Delta\mathrm{CCC}^{*}\mathrm{Revenue} + \Delta\mathrm{CCC}^{*}\Delta\mathrm{Revenue} \tag{4}$$

Eq. (4) is similar to the concept of working capital productivity (BCG, 2004), which measures the ratio of the CCC to sales rather than cost of goods sold (for DIO and DPO). The result is a direct relationship between the CCC (days), OWC, and sales. Fig. 2 illustrates a representation of Eq. (4).

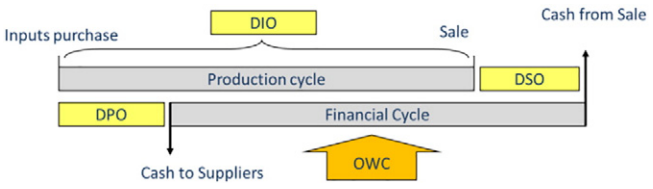

Fig. 1. Graphical representation of the linear relationship between the CCC and OWC.

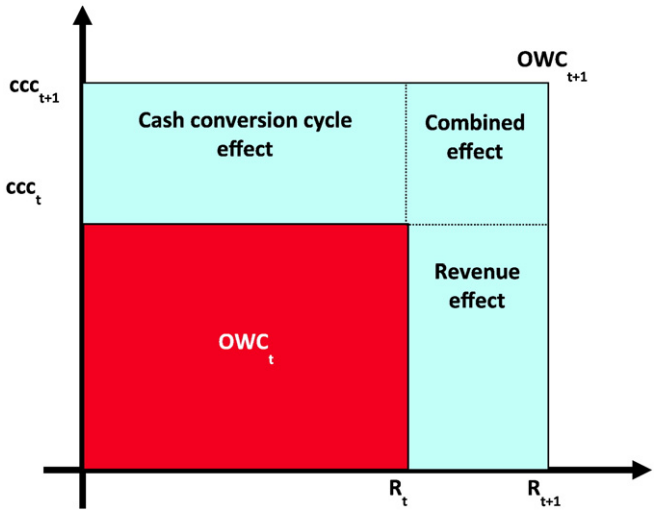

Fig. 2. Decomposition of changes in operating working capital over time.

In Fig. 2, the revenue effect is value creating, the CCC effect value destroying, and the combined effect destroy or create value depending on the relationship between the profit margin and opportunity cost of working capital investments. By allowing only the CCC or sales (revenue) to change, we clearly have two transmission mechanisms from investment to profits: the revenue and CCC effects.

Given the constant operating margin hypothesis, profits are a linear function of the increase in sales. If π is profits, P price, c average *COGS*, and Q the quantity of goods and services sold:

$$\pi = (P-C)^{*}Q \tag{5}$$

If the CCC is constant and positive, then cash flow and profits move in tandem, and working capital investments are[2]

$$\Delta\text{OWC} = \text{CCC}^{*}\Delta\text{Revenue} = \text{CCC}^{*}(P-C)^{*}\Delta Q \tag{6}$$

It is trivial to note that optimizing OWC means minimizing the CCC conditional on its effects on operating margins and actual sales. Minimizing the CCC means fewer investments for the same amount of profits, thereby maximizing shareholder value if there are no impacts on sales (e.g., lost sales due to decreasing the period for consumers to pay for their purchases).

The revenue effect is a classic indicator of capital budgeting. Firms budget working capital investments in line with expectations of increased sales. The CCC effect thus influences the profitability of WCM. In this respect, the present framework reconciles most of the results in the empirical literature. One can easily see why working capital investments might destroy value: without ex-ante assumptions, such investments might lead to an increase in sales (value enhancing); nevertheless, they can also result in increasing the CCC (value destroying). Since most companies do not monitor or manage their CCC, overinvestment in working capital is frequent because of the inefficiencies related to the CCC; any working capital investment that results in a higher CCC without operating margin effects destroys value.

In summary, the present framework allows us to separate working capital investments into two types:

1 1 OWC investment (ΔOWC) that leads to higher sales is profitable as long as the operating margin is constant and higher than the firm's cost of capital.
2 ΔOWC that prompts a higher CCC, ceteris paribus, destroys an amount of value equal to the present value of ΔOWC, of at least (where *EV* is enterprise value):

$$\Delta EV = -\frac{\Delta\text{OWC}}{wacc} \tag{7}$$

Eq. (7) reconciles all previous empirical results on the inefficiency of working capital investments. In particular, it may drive the results in Kieschnick et al. (2013), 2006), who find that firms overinvest in working capital and that an incremental dollar invested in net OWC is worth less than an incremental dollar held in cash. In other words:

[2] CCC can be and is negative for many companies, with important implications. The main one is that revenue growth generates increased cash flow. By increasing cash flow while growing, companies with a negative CCC, as defined in the present framework, face fewer restrictions on capital investments than most companies (one example is Amazon).

Hypothesis 1. Any investment in OWC (inventories, accounts payable, accounts receivables) that does not generate sales or a higher operating margin destroys a firm's enterprise value by at least $\Delta EV = -\Delta \text{OWC} - \frac{\Delta \text{OWC}^* g}{wacc}$ given a constant growth rate g for revenue; alternatively,

Hypothesis 1.1. Any permanent reduction in the CCC that does not affect the operating margin or volume of sales will create shareholder value by, at least:

$$\Delta EV = \left|\Delta \text{CCC}^* \text{Revenue}\right| + \left|\frac{\Delta \text{CCC}^* \text{Revenue}^* g}{wacc}\right| \tag{8}$$

Assuming that a firm's opportunity cost is its *wacc*, any investment in working capital that does not generate sales or improve the operating margin results in capital tied up in operations that generates no rate of return. The present value of such an investment should be discounted at the cost of capital; this would be the sum of an infinite series, which equals the initial investment, ΔOWC, that would grow at the same rate as the growth in revenue, g. This hypothesis is trivial at first; however, unlike other types of investments, it does not depreciate at any rate. It can only be recovered by streamlining operations, which yields this amount back into cash holdings, or n days after the company ceases its operations, where n is DSO.

The alternative hypothesis has different implications, even though it is formally identical to its original formulation. A permanent reduction in the CCC, without changes in the operating margin or sales dynamics, frees up cash equal to $\Delta OWC = \Delta \text{CCC} * \text{Revenues}$ in the first period. More importantly, it also diminishes the need for future investments in working capital as sales grow. Here, we assume a constant growth in sales, g, to simplify the exposition.

Mismanaging DIO, DSO, and DPO results in the greater allocation of cash, which increases the cost of capital but generates no marginal return. We can reconcile other empirical results with the present framework as follows:

1 1 Financially constrained firms have trouble with rapid increasing sales (e.g., Bierman and Smidt, 2012).
2 Shortening the CCC improves firms' profitability, especially for financially constrained firms such as SMEs (Carpenter and Petersen, 2002; García-Teruel and Martínez-Solano, 2007). Managing inventories, accounts payables, and accounts receivables can sharply improve the return on working capital investments, above all if a firm can do this without losing sales. This also explains why investments in DSO are more profitable than those in DIO as in Kieschnick et al. (2013). On the one hand, DSO investments should result in higher sales, and it is easy to assume that the investment would have a greater revenue effect than the CCC effect. On the other hand, investments in DIO are not directly linked to higher sales, and they should influence the CCC effect first (see Fig. 1). For example, optimal inventory policies usually relate to fluctuations in the price of raw materials (Berling and Martínez-de-Albéniz, 2011). Mapping the effect that increases OWC significantly changes the relationship between managing the components of working capital and profitability. In particular, cash-starved firms should try to raise cash internally by shortening the CCC.
3 The combined effect highlights a pressing issue for rapidly growing firms because rapid growth often results in the mismanagement of the CCC, compounding the liquidity issues resulting from increasing revenue. Hambrick and Crozier (1985) first illustrated this issue, and subsequent studies have highlighted the relevance of cash management for rapidly growing firms and SMEs (Beck and Demirguc-Kunt, 2006). Moreover, most companies in emerging markets do not use the key performance indicators of the CCC and thus lack a cash culture (KPMG, 2010).
4 It presents a compelling argument for the U-shaped curve reported for privatized companies (Ben-Nasr, 2016). Financially constrained companies invest little in working capital and thus have lower growth and value, while firms that invest too much suffer from the value-destroying CCC effect.

Finally, it is easy to reconcile the research results of Kieschnick et al. (2013) and Almeida and Eid (2014). Any positive changes in the CCC yield significantly less value from extra investments in working capital, on average, than an extra investment in cash. Unless companies manage their CCC correctly, increasing the level of working capital at the beginning of a fiscal year should reduce company value for any value in excess of the revenue effect. Although the CCC and sales are usually correlated, if companies can shorten the CCC without losing sales, they could improve the return on working capital investments. Moreover, the present framework illustrates a tentative link between negative cash flows and working capital investment restrictions that could lead to asymmetric cash flow sensitivity to cash (Bao et al., 2012), as financially constrained companies would be unable to support negative cash flows and invest in working capital for growth purposes.

We provide evidence for some of these points in the empirical section. We go further by showing how better working capital management can improve cash flows by using the case study of a large corporation that is not financially constrained. For financially constrained companies, this issue should be even more important. In that sense, we reinforce most of the arguments in the literature and show that the inefficient allocation of working capital investments may be pervasive in emerging markets and a much more important issue for shareholder value than previously thought.

Studies of the actions that firms actually take to manage their CCCs are scarce, although some authors provide indirect evidence that improving operations enhances working capital investments (Gardner et al., 1986; García-Teruel and Martínez-Solano, 2007; Baños-Caballero et al., 2010, 2012, 2014). Nevertheless, anecdotal evidence abounds. In one executive education class in which CCC management was the topic, one of the authors witnessed a particularly interesting event while explaining

the relevance of the CCC to the dynamics of working capital investments. At one table sat four family members of a small company: the CEO and founder, the director of marketing, and two of the CEO's daughters, who were both senior managers in the company. In the middle of the class, the daughters started vigorously complaining to the CEO about the damage of his policy of paying every suppliers' invoice exactly when the company receives it based on the simple argument that he hated being in debt. They decided, on the spot, to establish a new payment policy: every invoice was to be paid on its due date. A rough calculation suggested that US$ 1.2 million would show up in cash and equivalents in the next few weeks, which happened. CCC management goes beyond low hanging fruit and, in many cases, is the denial of a free lunch.

Kieschnick et al. (2013) show that improvements in DSO increase shareholder wealth more than improvements in DIO. Molina and Preve (2009) study the trade receivables policy of distressed firms as part of a trade-off between the willingness to gain sales and the need for cash, finding that firms increase trade receivables when they have profitability problems, but reduce trade receivables when they have cash flow problems. For non-distressed firms, managers should optimize trade receivables such that a marginal increase in sales would not compensate for the cost of capital in increased working capital.

To bridge this literature gap, we now turn to evidence that explicitly links operational efficiency with financial performance in the context of CCC management. We focus on the case of the real estate market in Brazil by looking at the effects of a CCC management project on MRV, a large listed company able to reduce its CCC significantly, starting in early 2013.

3. Direct evidence: MRV and its cash conversion cycle reduction

In this section, we first describe the industry in relation to the recent evolution of the economy and then present some stylized facts about the company and the unique business model of real estate companies in Brazil that participate in the Minha Casa Minha Vida (MCMV) program. Finally, we describe the intervention in MRV, a large listed company in the real estate industry in Brazil, for the reduction of its CCC and show the direct evidence of shortening its CCC, with the economic implications.

3.1. Brazil's housing market

The real estate industry in Brazil has changed drastically since the mid-2000s. Most large companies went public in the short period from 2005 to 2007. Moreover, the market to that point dealt with a long, severe period of low demand for housing due to high interest rates, low income growth, and general macroeconomic uncertainty, even after hyperinflation was tamed in the mid-1990s.

In 2005, credit started to take off, increasing from 25% of GDP to more than double that in 2016. Even with a severe recession that started in 2014, credit in 2016 is over 50% of GDP, as shown in Fig. 3. The same phenomenon occurred in the housing market. Property loans were 1.5% of GDP in 2007, and reached 7.9% of GDP at the end of 2013. Total credit to households in 2016 is higher than the credit to the whole economy 10 years earlier. Until 2004, household demand for credit and housing in Brazil was repressed by the macroeconomic environment and absence of liquid credit markets. Since then, there has been an intense diffusion of financial products to families, many of which were accessing banking credit for the first time. As real wages increased and the unemployment rate reached low levels, consumers became more confident about increasing their debt. At the same time, the central bank cut interest rates, which made installments more affordable to families.

In 2009, the Brazilian government launched the MCMV housing program ("My House My Life") with subsidized loans to low income families (annual incomes of up to US$ 30,000). Subsidies totaled US$ 100 billion and more than three million homes were built as of 2016. Higher credit programs such as MCMV were one of the two main drivers of the development of the real estate industry in Brazil in 2004–2016. Real estate companies' revenue more than tripled in real terms, leading to higher investments in working capital.

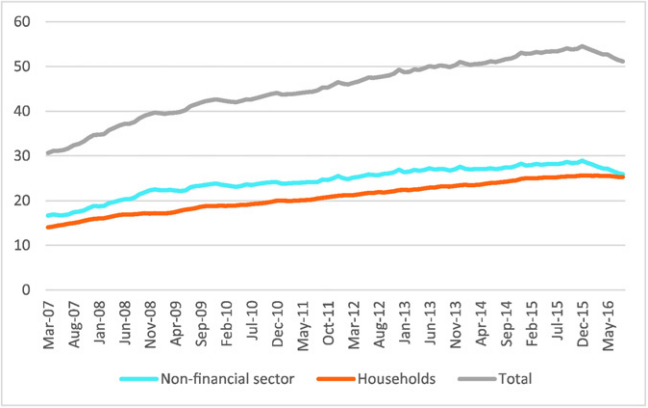

Fig. 3. Outstanding bank loans for corporations and households (% of GDP). (Source: Brazilian Central Bank, 2016.)

Fig. 4. Economic cycle of Minha Casa Minha Vida.
(Source: Albuquerque (2014).)

Given that the market was flat for a long time before accelerating in the mid-2000s, companies scrambled to meet repressed demand by acquiring as much usable land as possible—a veritable "land gold rush." Land banks became the norm, and companies filled it, resulting in high inventories. Companies then adopted sales as a financial metric. Because the industry's economic cycle is long, up to five years from buying land to selling and building all units, companies realized that a significant increase in sales did not necessarily result in higher shareholder return. Much of the previously purchased land was unusable for many reasons, and escalating costs prevented many new projects from generating positive returns. The market then shifted to operating margins as its main financial metric. Yet, owing to the financial crisis and the long cycle, companies generated sales with positive operating margins but were short of cash. WCM is something that no company in the construction sector pursues, according to interviews with senior managers, and they do not employ working capital managers. Liquidity thus became a serious problem for companies during 2010–2013. All listed construction companies in Brazil, except for Gafisa, are family-owned or have a defined controlling shareholder. Lins et al. (2013) show that family-owned firms experienced severe liquidity shocks following the financial crisis that started in 2007. As a result, family-owned firms cut investments more relative to other firms, and these cuts are associated with greater underperformance. Although some construction companies are already moving towards return on equity as a financial metric, most still use one of the previous metrics.

3.2. MRV and operating working capital

MRV is a large real estate company in Brazil that specializes in the residential housing market, with a particular focus on low income families, especially after the creation of the MCMV program. In 2015, the company built 2.1 million square meters and delivered 40,000 homes. Before 2006, the company averaged 3000 units per year, increasing this to 25,000 in 2007–2010 and >38,000 per year since then. There are two main characteristics for companies in the same industry: strong revenue growth and the long economic cycle. MRV is an ideal case study because the company (1) needs to generate more cash for its growing investment opportunities and (2) by being the first to adopt a WCM program, it provides us with a natural experiment, since it can be compared with its close and distant competitors. MRV's business model, like its competitors, is based on long operating cycles, which generates large OWC requirements. More importantly, the MCMV business model leads to a relatively stable operating margin, an ideal situation under which to test our main hypothesis. Moreover, as previously noted, external validity can be established by comparing it with its peers, namely all listed companies with available financial information and the same constraints as MRV.

3.2.1. MCMV business model and the need for shortening the CCC

In the MCMV model, sales can only begin after the project is incorporated, and construction follows a certain percentage of sales. There is also a gap between sales and the transfer of contracts from companies to final consumers. The sales outstanding cycle is tied to the unique business model of companies that build homes for MCMV. Projects related to MCMV have an economic cycle of roughly five years. Fig. 4 describes the cycle, which goes from purchase to registration, sales, and construction.

The sales outstanding cycle is long and cannot be shortened by securitizing receivables because it is directly related to the regulated process of transferring housing to final consumers. There is a long period from sales to cash flow; Caixa, the Brazilian state-owned bank responsible for financing MCMV consumers, only disburse funds after measuring the evolution of the construction, the last step in the economic cycle. This business model is related to how the government set up the subsidies for the MCMV program. Companies cannot change the model, but they can work to speed up the process, especially in terms of registration and incorporation, sales, and contract registration with the financial institution.

3.2.2. CCC efficiency through operations: the MRV case

MRV established a CCC management program to lower OWC and free up cash for use in its investment projects, implementing it from January 2013. The project has five phases: analysis of the company's data, benchmarking, simulation of possible gains, critical factors to reduce the CCC, and proposed actions. The project to lower MRV's OWC started from the initiative by Albuquerque (2014), under the supervision of one of the authors of this paper. MRV, as with most companies in its market, have more investment opportunities than cash holdings because of the increase in demand, especially from MCMV projects. Table 1 reports the data for the company in the years before the project began. The CCC is particularly long, around 508 days in 2012. The values are converted at an exchange rate of BRL 2 per US$1, which is the average over 2010–2013.[3]

[3] The present exchange rate will generate a higher savings value in USD than the exchange rate in June 2016 (3.2 BRL per USD). Regardless, the amount of shareholder value is high in any currency.

Table 1
MRV's operating working capital, 2010/2012 (US$ '000).

	2010	2011	2012
DSO	389	419	440
DIO	227	244	280
DPO	134	174	212
CCC	482	489	508
OWC	1,994,655	2,689,540	2,647,035
Annual revenue	1,510,475	2,007,530	1,901,905

Table 1 reports data for MRV's cash conversion cycle, calculated as CCC = DSO + DIO = DPO, in which DSO is days of sales outstanding, DIO is days of inventory outstanding, and DPO is days of payment outstanding, all related to annual revenue. All variables are calculated through balance sheet and income statement data. Values are converted from BRL to US$ at 2 to 1.

Table 1 shows that the CCC increased during 2010–2012 from 482 days to 508 days, although DPO increased sharply. The growth in the cycle increases the working capital requirement faster than revenue, decreasing the marginal return on working capital investments. There is a cyclical component of the behavior of the CCC; incorporating more units of subsidized housing, with its longer economic cycle, can change the cycle over any small period. Even so, the company overlooked many aspects of inventory and sales management.

How does MRV compare with its peers? Table 2 shows the CCC pattern for all listed companies in the MCMV market. These companies have similar profiles in terms of geographical dispersion, product portfolio composition, and history (all companies were listed in a three-year window) among other characteristics. External validity can also be inferred because markets with long economic cycles are common, and most industrial and commercial companies face the same constraints in terms of a positive CCC that generates higher working capital investment as revenues increase.

In the Brazilian real estate market, every company, from medium-sized Even and Ez Tec to the largest companies such as PDG and Cyrela, has a long CCC, at least 362 days for the firm with the shortest CCC and up to 836 days for PDG. MRV's CCC (508 days) is thus below the market average (561 days). However, this is mostly because it has the longest DPO among its peers, 212 days. In fact, MRV's DIO (440 days) and DSO (280 days) are almost at the market average of 442 and 270 days, respectively.

The case of MRV is similar to those of other companies in the real estate and construction sectors for three reasons. First, all companies, including its direct competitors, follow similar economic cycles because of the business model imposed by MCMV. The requisites for sales and construction are identical and thus the CCC varies across companies due to differences in the quality of inventory, how quickly each manages to turn over inventory, and each company's terms with suppliers. Second, companies grew at similar rates in the sample period. This growth evens out the revenue effect among companies in the MCMV program, allowing us to concentrate on CCC changes as value creating. Finally, the Brazilian market is far from efficient in the quality of senior management. This allows us to posit that companies in the sample are far from the optimal CCC, providing a background in which a competitive advantage in terms of CCC management can generate large effects in comparison with other companies in the industry.

The main issue in establishing the parameters of CCC improvement policies is how to integrate operations and financials to avoid compromising profitability. There are two competing effects: a longer CCC increases profitability if it allows companies to increase sales; however, the opportunity cost of investments in working capital affects the bottom line (Deloof, 2003). A successful CCC management program will thus allow a firm to shorten its CCC without losing sales. In the present case, this means looking at the company's operations to unearth the possible sources of inefficiencies that affect DIO and DSO.

A thorough analysis of MRV operations identified five possible areas in which to improve its CCC: a reduction in average purchasing and land registration times, project design, financing, commercialization, and the registration of individual contracts. None of these processes involved actually building housing units. For each of these areas, the next step was to develop possible interventions to reduce average execution time.

In the case of purchasing and land registration, some actions included creating a checklist with all possible variables that could affect the lifecycle aspects of the project, from purchasing to construction; consulting with water and sewerage companies to check for possible emerging issues before committing to land purchases; and offering incentives to land buyers to attach their bonus to the lifecycle of the investment project.

Project design actions incorporated determining two “owners” of each project, one from each of the engineering and architecture departments. “Owners” would oversee projects to ensure all deadlines are met and minimize rework. Additionally, the company designed a new process in which project design is developed alongside the material and equipment purchasing for the buildings to minimize repeated works on projects. Financing solutions entailed registering a “pre-project” with the financial institution and interventions to minimize the internal processing of consumer applications.

Regarding commercialization, the company restructured the operations of sales teams by giving scaling up incentives on the speed of sales rather than only on general revenue. Finally, in the case of individual contract registration, the company hired new contractors to speed up registration with local notaries, hired new employees to support the sales teams in the checklist of documents for mortgage applications, and established a pre-validation of standard mortgage contracts with local notaries before the beginning of sales.

Table 2
CCC and other financial measures, Brazilian companies, 2012 (US$ '000).

	MRV	Cyrela	Gafisa	Brookfield	PDG	Rodobens	Even	Ez Tec
DSO	440	386	354	485	644	386	339	506
DIO	280	251	240	359	382	157	177	329
DPO	212	198	142	202	190	181	66	88
CCC	508	439	452	642	836	362	450	747
OWC	2,647,035	3,383,908	1,736,856	2,406,621	5,000,311	476,505	293,110	647,127
Revenue	1,901,905	2,813,500	1,402,550	1,368,250	2,183,150	480,454	237,745	316,200
EBIT/revenue	15%	16%	4%	−5%	−42%	16%	15%	39%
Profits/revenue	13%	13%	−2%	−12%	−50%	11%	13%	42%

Table 2 reports data for the CCC of MRV and its direct competitors, along with OWC, annual revenue, EBIT/Revenue, and Net Profits/Revenue. All variables are calculated using firms' balance sheet and income statements for 2012. Values are converted from BRL to US$ at 2 to 1.

Take purchasing and land registration, for instance. Bulan et al. (2009) show that the irreversibility of investments affects how developers make decisions related to price uncertainty and exposure to market risks. Gehner (2008) analyzes the many risks developers take when competing for land banks. MRV and many other companies in the Brazilian market face bureaucratic issues related to construction permits and other measures, which often result in sales and building delays. Reducing delays by restructuring internal processes decreased DIO without any loss in sales or inventories.

Mortgage applications are another example of a instance in which it was possible to reduce CCC without any impact in operating margin. The usual process at MRV was for salespeople to check the documents included in the mortgage application. Yet, incentives were skewed towards sales rather than checklists, and many applications arrived at the bank with incomplete or illegible documents. Thus, the applications came back to the salespeople, who had to contact the buyers to return with more documents, which significantly delayed the registration of mortgage applications with banks and thus tied up the company's funds.

Nonetheless, no action represented a major restructuring of the company's processes. All changes started to be implemented in January 2013. Table 3 presents the impact of the restructuring of MRV's operations on its financial results in the subsequent years. For the results of 2015, we create a simple counterfactual in which the CCC would be at the same level as 2012 to compare actual OWC with that with a constant CCC.

Revenues increase by 25% from 2012 to 2015. One should expect working capital to increase in tandem, but this drops by 13.5%, or US$ 358 million. It is hard to determine the strict causality between the CCC management project and aggregate result shown in Table 3, but the evidence is compelling in its favor considering the effects of stock prices and the relationship between Tobin's Q and the CCC, established in the next section. We can see that even if DPO decreases, both DSO and DIO drop sharply. DSO is 29% lower when one compares the value from 2015 to 2012, and DIO is 27% lower between these two years. If we compare the 2015 CCC results with our counterfactual, we arrive at a lower working capital requirement of US$ 1.02 billion, a strong case for improvements in WCM and its effects on free cash flow. In the next section, we use a synthetic control methodology to highlight the difference between what happened in MRV and that with its competitors.

Presently, we have a compelling case for an economic impact of the project that started in 2013. In efficient financial markets, if any exogenous shock, like the reduction in the CCC in our case, generates economic profits, stock prices and/or profitability should be affected. We now turn to indirect evidence to strengthen the case regarding our main hypotheses.

4. Indirect evidence: synthetic controls and dynamic cash flow management estimation

This section is divided into two subsections. In the first, we search for evidence of the impact of the intervention at MRV, using a synthetic control approach. In the second, we look for the impact on the company's profitability by using a modified Eq. (6) and Tobin's Q as the dependent variable.

Table 3
CCC and OWC at MRV, 2010–2015 (US$ '000).

	2010	2011	2012	2013	2014	2015	2015*
DSO	389	419	440	371	339	313	440
DIO	227	244	280	233	212	203	280
DPO	134	174	212	176	172	165	212
CCC	482	489	508	428	379	351	508
OWC	1,994,655	2,689,540	2,647,035	2,269,468	2,175,112	2,289,024	3,314,553
Daily revenue	4139	5500	5211	5302	5735	6525	6525
Annual revenue	1,510,475	2,007,530	1,901,905	1,935,305	2,093,093	2,381,519	2,381,519

Table 3 reports the data for the CCC and OWC at MRV. Values are converted from BRL to US$ at 2 to 1. 2015* represents the OWC that the company would have if it maintained the same CCC as in 2012.

4.1. Data

For both sets of indirect evidence and the robustness section, financial statements data come from Economatica. The process improvements that tie OWC to changes in internal practices are described by Albuquerque (2014). Restructuring started in the first quarter of 2013; hence, we assume that markets can only capture changes right after the announcement of the second quarter's financial results. The rationale for this is simple: the implementation of CCC management projects take time and analysts cannot distinguish between CCC volatility and structural changes without subsequent data on CCC changes. We compare MRV with its direct and distant competitors, chosen with the following criteria. The first set of companies includes all the listed companies that compete direct with MRV in the MCMV market: Cyrela, Gafisa, PDG, Rodobens, Even, Brookfield, and Ez Tec. The second set has other construction companies listed on the Brazilian stock exchange: CR2, Direcional, Helbor, JHSF Part, Joao Fortes, Lix da Cunha, Rossi, Tecnisa, Trisul, Viver, and Sultepa.

4.2. Synthetic control and structural CCC changes

The methodology of synthetic controls is suitable for small-sample case studies. Synthetic controls were developed by Abadie and Gardeazabal (2003) and Abadie et al. (2010) for situations such as the case of the CCC management program at MRV. Synthetic control is an evolution of a difference-in-difference approach in which treated and untreated units are compared over time. The distinction of synthetic controls is that weights are different among untreated units, with a weighted average of untreated units that closely matches the treated units over the pre-treatment period (Galiani and Quirstoff, 2016). The main advantage of the synthetic control approach is to create a counterfactual and test if the treatment effect has a significant impact on the unit compared with the weighted average of untreated units. The results are shown graphically with placebo effects that capture the possible variations between the actual MRV and synthetics created by the weighted average of its direct and distant competitors.

A necessary condition for the use of this methodology in small-sample case studies is balanced observables. This makes us confident that the unobservables are also balanced. In the present case, the main assumption is regarding managerial (in) competence. We assume that all companies are equally incompetent in managing their CCC which conforms to other article that shows that Brazilian companies behave differently than what is expected by economic theory (e.g. Zeidan et al., 2017). By implementing a project on shortening the CCC without any impact on sales and costs (i.e., the treatment effect), the result for MRV would be an increased cash flow compared with its counterfactual.

We follow the methodology of Abadie et al. (2010, 2015), who present the full exposition of the methodology. In short, suppose a sample of $J + 1$ companies indexed by j, among which unit $j = 1$ is the case of interest, MRV, and units $j = 2$ to $j = J + 1$ are its direct competitors. For a balanced panel, T_0 indicates the pre-intervention period and T_1 the post-intervention period. MRV is exposed to the intervention, described as the initiation of the CCC management project, in the first quarter of 2013 ($T_0 + 1$). The synthetic control is the weighted average of its direct competitors. This is a $(J \times 1)$ vector of weights $W = (w_2, \ldots, w_{J+1})$, with $0 \le w_j \le 1$, for $j = 2, \ldots J$ and $w_2 + \ldots + w_{J+1} = 1$. The heart of the methodology is the selection of W such that the characteristics of MRV are best related to the characteristics of the synthetic control.

Let X_1 be a $(k \times 1)$ vector containing the values of the pre-intervention characteristics of MRV that we aim to match as closely as possible, and let X_0 be the $k \times J$ matrix collecting the values of the same variables for the other companies. We select the synthetic control, W^*, that minimizes the size of the difference $X_1 - X_0W$ between MRV and its competitors.

With that in hand, let Y_{it}^N be the outcome that would be observed for all companies at time t in the absence of the interventions, with Y_{it}^I the outcome to which the companies are exposed in the CCC management project in periods $T_0 + 1$ to T. Let $\alpha_{it} = Y_{it}^I - Y_{it}^N$ be the effect of the intervention for MRV in the first quarter of 2013 and zero otherwise. The observed outcome for MRV at time t is

$$Y_{it} = Y_{it}^N + \alpha_{it} D_{it} \tag{9}$$

Given only MRV goes through the project, the goal is to estimate $(\alpha_{1T_0+1}, \ldots, \alpha_{1T})$. Because Y_{it}^I is observed, estimating α_{1T} requires estimating Y_{it}^N. Y_{it}^N is given by the factor model

$$Y_{it}^N = \delta_t + \theta_t Z_i + \lambda_t \mu_i + \varepsilon_{it} \tag{10}$$

where δ_t is an unknown common factor with constant factor loadings across units, Z_i is an $(r \times 1)$ vector of the observed covariates (not affected by the CCC program), θ_t is a $(1 \times r)$ vector of the unknown parameters, λ_t is a $(1 \times F)$ vector of the unobserved common factors, μ_i is an $(F \times 1)$ vector of the unknown factor loadings, and the error terms ε_{it} are unobserved transitory shocks at the region level with zero mean. Eq. (10) generalizes the usual difference-in-differences (fixed-effects) model that can be obtained if λ_t in Eq. (1) is constant for all t. A synthetic control such that

$$\sum_{j=2}^{J+1} w_j^* Z_j = Z_1 \quad \text{and} \quad \sum_{j=2}^{J+1} w_j^* \mu_j = \mu_1 \tag{11}$$

would be an unbiased estimator of Y_{it}^N, but this is dependent on the unobserved variables. Given our assumption that managerial competence is balanced in the period preceding the CCC project, the factor model provides the link between the observable and unobservable variables such that Eq. (11) holds approximately.

4.2.1. Implementation

Case studies of listed companies are perfect candidates for the synthetic control methodology, as interpolation on many dimensions of data, such as revenue, costs, and debt, rarely suffers from non-linearity, which can decrease the efficiency of the estimator. In the present study, the treatment effect is the MRV implementation of the CCC management program starting in the first quarter of 2013, but with measurable effects on the second quarter of 2013, right after the announcement of the second quarter financial results. July 2013 is the date for our treatment period. As the pre-treatment period, we chose the period starting March 2009 to avoid the global financial crisis. Additionally, the MCMV program was launched in the same month. The data cover March 2009 to December 2015. The result is then 28 quarters, with 18 pre-treatment and 10 post-treatment periods.

The synthetic MRV has a similar operating margin, short- and long-term debt, fixed assets, and total equity as the real MRV. Our outcome variable is free cash flow to equity. Two sets of companies are used to build the synthetic MRV. The first combines only direct competitors: Cyrela, Gafisa, PDG, Rodobens, Even and Ez Tec. Brookfield is dropped since it delisted in 2015. The second set has the other construction companies: CR2, Direcional, Helbor, JHSF Part, Joao Fortes, Lix da Cunha, Rossi, Tecnisa, Trisul, Viver, and Sultepa. To find the weights, the objective function minimizes the distance between the treatment and weighted control unit covariates. The sum of the weights must be 1.[4]

The weights are as follows: Cyrela (0.185), Gafisa (0.109), PDG (0.057), Rodobens (0.112), Even (0.327), and Ez Tec (0.211). For the distant competitors, the weights are CR2 (0.018), Direcional (0.108), Helbor (0.042), JHSF Part (0.089), Rossi (0.502), Tecnisa (0.121), Trisul (0.033), and Viver (0.086). For Sultepa, Joao Fortes, and Lix da Cunha, the weights are 0. Table 4 presents the summary statistics for the real and synthetics.

Figs. 5 and 6 report the results from the synthetic control methodology with a sample of counterfactuals for the post-treatment period. Fig. 5 shows the placebo controls for direct competitors and Fig. 6 shows that for distant competitors.

Things do not change if we consider other competitors from the same industry.

Figs. 5 and 6 show the results for MRV and the synthetic MRV with a group of placebo gaps. The results are robust at the 1% level of confidence, which means that we are confident that MRV achieved higher free cash flow to equity than it would have without intervention in its CCC. These figures show the stark difference in terms of free cash flow between MRV and the synthetic MRVs, beginning in the second semester of 2013. The difference also increases over time, which would be expected if the decrease in the CCC is permanent. We now turn to investigate if the CCC management project affects stock prices. In other words, do investors value the extra free cash flow generated from the CCC project implemented by MRV?

4.3. Event study

In this section, we regard the CCC project as an event transmitted to stock prices after the disclosure of the second quarter results in 2013. Again, we compare MRV with its direct competitors that participate in the MCMV program and other companies in the construction sector. In both cases, companies are commonly affected by increases in input prices and demand for construction services.

We use MacKinlay's (1997) standard event study methodology to address the effect on stock prices. Fig. 7 shows that the normalized stock prices (100 in December 2009) for the sample companies in the construction sector do not show a clear pattern from December 2009 to May 2016. We start in December 2009 because of the volatility in stock prices due to the financial crisis. Such volatility effects are smoothed out in the quarterly financial results; however, this makes inferences regarding changes in stock prices much less precise or interesting.

For each company, the event starts in the second quarter of 2013, after June, because companies post quarterly results in early July and monthly returns would pick up information from this announcement. We obtained stock price and balance sheet data from Economatica for December 2009 to April 2016. We estimate results for 1-, 6-, 12-, and 24-monthly windows as robustness controls. We measure the impact of the event in terms of the effect on stock prices and CCCs. For the first, the abnormal rate of return (AR_{it}) is the difference between the actual return ($r_{i,t+e}$) and the forecast rate of return ($_{R\ i,t+e}$):

$$AR_{it+e} = r_{i,t+e} - R_{i,t+e} \tag{9}$$

We employ a GARCH (1,1) model that accounts for time-varying volatility effects. The simplest specification, given that we are using monthly data, is better suited for stock price data. The sigma-algebras ψ_t and h_{it-1} represent the information set at time t for firm i and the conditional variance, respectively. We assume a normal distribution. The equations are

$$r_{it} = C_i + \beta r_{mt} + \sum \lambda_h r_{i,t-h} + \varepsilon_{it} \tag{10}$$

[4] We use the synthetic control methods developed for comparative case studies. The optimization procedure and results come from the synth package. For more detail, see Abadie and Gardeazabal (2003) and Abadie et al. (2010).

Table 4
Stock price predictor means (in '000 US$) for direct competitors.

Company	MRV		Average of all companies
	Real	Synthetic	
Panel A – direct competitors			
Fixed assets	918,646	923,125	1,977,996
Short-term debt	165,957	167,878	242,647
Long-term debt	940,174	950,410	459,800
Total equity	1,905,013	1,824,605	1,619,198
Operating margin	0.332	0.310	0.201
Panel B – distant competitors			
Fixed assets	918,646	900,271	490,470
Short-term debt	165,957	163,559	99,297
Long-term debt	940,174	918,415	236,100
Total equity	1,905,013	1,892,935	530,322
Operating margin	0.332	0.302	0.278

$$\varepsilon|\psi_{it-1} \sim N(0, h_{it}), h_{it} = \alpha_i + \sum \alpha_{ik}\varepsilon^2_{i,t-k} + \sum \theta_{ij} h_{i,t-j} \tag{11}$$

Table 5 presents the GARCH model results. We can see two significant effects. MRV stock has a positive and increasing abnormal return over 24 months. This reinforces the perennial nature of the CCC management project: the financial cycle decreases every quarter for the two-year period. The increasing abnormal rate of return seems to indicate a positive and lasting effect from the company's restructuring of its operations.

The model captures some abnormal results in the first month for some companies, which is expected, because July 2013 saw all companies posting quarterly results. EZ Tec also shows abnormal returns after 24 months, while Lix da Cunha shows abnormal returns after 1 year. We cannot explain those results, but it does not diminish the economic consequences of the findings for MRV.

By using a GARCH model, we can track the effects of the event over time. We use the market portfolio as the benchmark to track the evolution of MRV and its direct and distant competitors. The results are robust in displaying the effect of the event regardless of the horizon we use. Moreover, the effect is increasing over time, again highlighting the continuous nature of the project. After the effect on free cash flow to equity and stock prices, we turn to the last piece of indirect evidence, the impact on profitability.

4.4. Profitability and CCC management

We modify Kroes and Manikas (2014) to estimate the impact of the CCC on profitability in a dynamic cash flow management framework. Additionally, we add a dummy variable for the second quarter of 2013, taking value 1 from this period on and zero

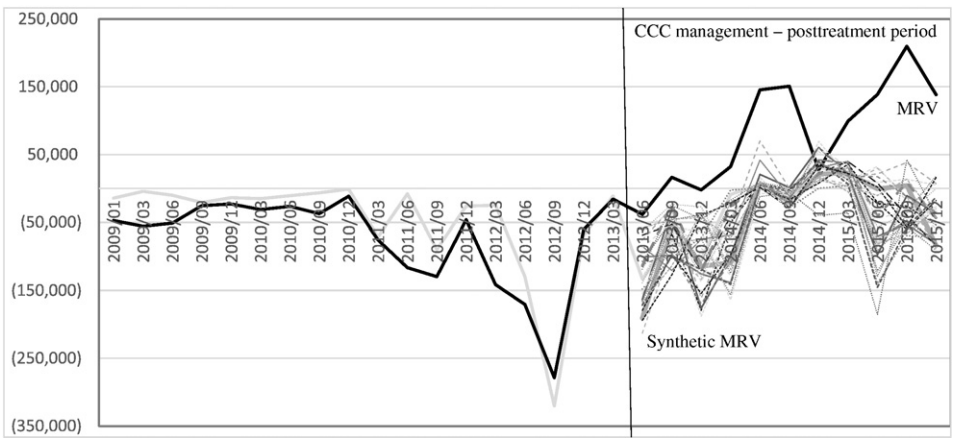

Fig. 5. Result for synthetic control and MRV: free cash flow and direct competitors (US$ '000). Fig. 5 displays the evolution of MRV and its synthetic control from 2009 to the end of 2015. The treatment period is 2013/2, when the free cash flow data from MRV should show the effect of the CCC management project. For the synthetic control with direct competitors, data for the post-treatment period come from placebo tests that illustrate the expected evolution of free cash flow.

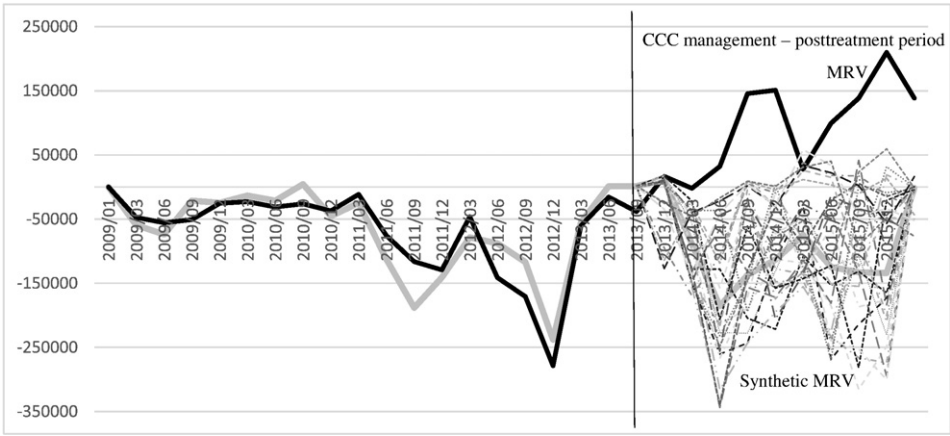

Fig. 6. Result for synthetic control and MRV: Free cash flow and distant competitors (US$ '000). Fig. 6 displays the evolution of MRV and its synthetic control from 2009 to the end of 2015. The treatment period is 2013/2, when the free cash flow data from MRV should show the effect from the CCC management project. For the synthetic control with distant competitors, data for the post-treatment period come from placebo tests that illustrate the expected evolution of free cash flow.

otherwise. Our sample consists of 19 companies and 33 quarters (for Brookfield, n = 29, since the company successfully completed a buyout and was delisted in 2015). Our sample is thus larger on n, but smaller on t than in Kroes and Manikas (2014). We modify their specification by taking to data a modified version of Eq. (6).

The main reason for modifying Kroes and Manikas (2014) is that the authors regress profitability on changes in the cash-to-cash cycle, controlling for the level of sales. From Section 2, we decompose changes in OWC as the revenue, the CCC, and combined effects. Tobin's Q, as a measure of profitability, should be affected by changes in revenue (if we assume a constant operating margin) as well as changes in the CCC. Changes in the cash-to-cash cycle would be transmitted to Tobin's Q through the more efficient use of working capital, in the same way that revenue growth creates shareholder value. We control for the level of debt, as in Kroes and Manikas (2014). Given that CCC reduction projects are long-lasting and only create value if their decrease is permanent, the past values of the CCC should still be value creating for some quarters after their reduction is first measured. We also introduce the combined effect (that is zero if either revenue or the CCC are constant), but only allow contemporaneous

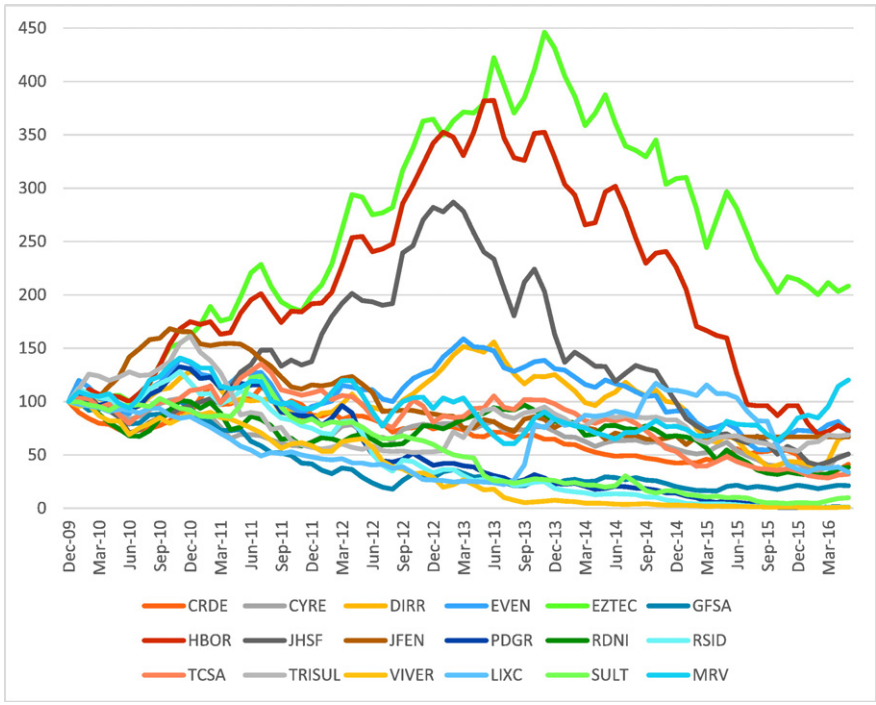

Fig. 7. Construction company stock prices, Brazil, December 2009 to May 2016. Prices normalized to 100 for December 2009. Brookfield (BISA) is not shown because it bought out its stock and was delisted in 2015.

Table 5
Monthly stock market performance after June 2013.

Company	July 2013	$t = 1$	$t = 6$	$t = 12$	$t = 24$
Panel A: direct competitors					
MRV	0.2%	**1.248**	**4.018**	**7.346**	**14.212**
Cyrela	0.6%	0.626	−0.674	−1.166	1.665
Gafisa	−12.2%	**−7.163**	−1.025	−0.141	−2.915
Brookfield	2.0%	0.967	−1.527	−0.223	−4.600
PDG	−15.6%	**−10.557**	−1.302	−1.750	−4.348
Rodobens	−0.4%	−0.372	−0.805	−0.863	1.100
Even	−2.7%	−0.686	−0.724	−0.903	1.061
Ez Tec	−6.6%	−0.589	0.153	−0.366	**17.903**
Panel B: other construction firms					
CR2	−6.6%	−1.551	−0.491	−1.422	0.461
Direcional	−9.4%	−0.414	−0.926	−1.617	2.791
Helbor	−5.4%	−0.392	−0.773	−1.291	**2.743**
JHSF Part	−12.6%	**−3.610**	−1.656	−2.301	0.634
Joao Fortes	−4.9%	**−4.883**	−0.500	−1.065	2.656
Lix da Cunha	18.5%	**8.544**	0.442	**10.025**	1.750
Rossi	−16.2%	−1.221	−1.795	−2.503	−4.487
Tecnisa	−2.0%	−0.032	−0.111	−1.281	0.619
Trisul	−3.0%	−1.005	−0.186	−0.492	2.310
Viver	−24.9%	**−6.860**	−3.086	−3.944	−4.726
Sultepa	−7.8%	−0.791	0.153	−1.394	−3.662

Table 5 reports the cumulative abnormal return (CAR_t) to the specified day t in event time from June 2013 onwards. Event time is months relative to June 2013. The first column presents the % in stock prices for July 2013. Abnormal returns are computed given the market model parameters estimated with the GARCH model $r_{it} = C_i + \beta r_{mt} + \sum \lambda_h r_{i,t-h} + \varepsilon_{it}$ through the period (−12; −1) in event time, where r_{it} is the continuously compounded return on date t and r_{mt} is the continuously compounded monthly market return on month t. The sample period runs from 24 monthly averages before July 2013 over the horizons in months in columns 3 to 6. Values in bold are statistically significant at 5%.

changes on it to affect Tobin's Q. We estimate the following equation:

$$\ln(\Delta Q_t) = \beta_0 + \beta_1 \ln(\Delta R_t) + \beta_2 \ln(D_t) + \beta_3 \ln(\Delta CCC_t) + \beta_4 \ln(\Delta CCC_{t-1}) + \beta_5 \ln(\Delta CCC_{t-2}) + \beta_6 \ln(\Delta CCC_{t-3}) + \beta_7 \ln(\Delta CCC_t \Delta R_t) + Dummy + e_{it} \quad (12)$$

Eq. (12), to the best of our knowledge, is the first to provide a theoretical framework to regress changes in the CCC to a multiple of a company's value (a measure of its profitability, or how well it uses its capital). The change (Δ) in a variable for period t is measured as the difference between its value at the end of the quarter and its value at the end of the previous quarter. We test the same hypothesis as Kroes and Manikas (2014): a reduction (increase) in the CCC is associated with an improvement (decline) in economic performance.

Table 6 presents the results related to the CCC. The results have the expected signs for all cases with significant coefficients. We also see that the pattern for MRV is the strongest, with the CCC effect being significant for the contemporary and lagged coefficients. It is also significant for both the combined effect and the dummy variable. For most companies, changes in the CCC affect profitability, but we cannot find evidence for all companies. Our argument is straightforward: companies are refusing a free lunch. Improvement in operations that reduce the CCC without affecting the operating margin or sales is a direct path to value creation, and a particular important opportunity for companies that are not expertly managed. The alternative scenario is that all companies already manage their CCCs optimally, and MRV is coming onboard after its project in early 2013. This is implausible, as there is no reason to find a priori competent management in most sectors in emerging markets, and surely so in Brazil, a country that suffers from brain drain and a long story of managerial incompetence, both in the private and in the public sector. The managerial gap found in the late 1990s (Fleury, 1999) is still prevalent in the 2010s (Nagano et al., 2014). More interestingly, changes in revenue do not seem to drive Tobin's Q. One explanation is that focus on cash flow or periods of high investments drives the changes in Tobin's Q more than sales dynamics.

Our results are consistent with our hypothesis that changes in the CCC increased MRV's profitability. The dummy variable is positive and statistically significant, providing evidence that the events in the second quarter of 2013 are driving our results. We perform robustness checks using different start dates for both estimations and check the dummy sensitivity to cash flow measures. The results do not change significantly, and we omit these for brevity.

We confirm these results by estimating two difference-in-difference panel data regressions for the direct and distant competitors. For each, we use three dummies to identify the impact of MRV's CCC management project on Tobin's Q. The first takes a value of 1 if the company is MRV and 0 otherwise. The other is the treatment (t) dummy that takes a value of 1 for the post-treatment period (2013/2 and after) and 0 otherwise [2009/1; 2013/1]. The last dummy is the variable of interest, which takes a value of 1 if MRV in the post-treatment period (MRV*t) and 0 otherwise. The results are similar to those in Table 6. The MRV project (the treatment effect) increases Tobin's Q (the difference-in-difference coefficient was statistically significant at the 5% level for both regressions). We omit the results for brevity; they are available upon request.

Table 6
Change in cash flow measures (dependent variable: ΔTobin's q).

Company	Intercept	Sales	Debt	CCC	CCC-1	CCC-2	CCC-3	CombE	Dummy
Panel A: direct competitors									
MRV	0.006	0.052	0.009	**−0.094***	**−0.142***	−0.010	**−0.232***	**−0.087***	**0.117***
	(0.033)	(0.057)	(0.210)	(**0.005**)	(**0.013**)	(0.015)	(**0.008**)	(**0.028**)	(**0.040**)
Cyrela	−0.045	0.051	0.000	−0.005	−0.030	−0.033	0.014	−0.034	−0.045
	(0.136)	(0.185)	(0.068)	(0.032)	(0.157)	(0.166)	(0.053)	(0.147)	(0.136)
Gafisa	−0.012	0.011	0.033	0.023	−0.006	−0.035	0.013	−0.024	−0.012
	(0.186)	(0.095)	(0.032)	(0.077)	(0.023)	(0.076)	(0.102)	0.004	(0.186)
Brookfield	−0.014	0.047	−0.043	**−0.052***	−0.008	−0.039	**−0.045****	−0.006	−0.014
	(0.068)	(0.191)	(0.172)	(**0.003**)	(0.180)	(0.142)	(**0.031**)	(0.146)	(0.068)
PDG	0.023	0.019	−0.043	0.026	0.026	−0.032	0.016	**0.038****	0.023
	(0.149)	(0.066)	(0.128)	(0.066)	(0.150)	(0.115)	(0.121)	(**0.015**)	(0.149)
Rodobens	0.023	0.041	0.002	−0.018	0.005	−0.014	−0.066	−0.003	0.023
	(0.133)	(0.164)	(0.149)	(0.046)	(0.108)	(0.152)	(0.006)	(0.022)	(0.133)
Even	0.013	**0.460***	−0.006	0.044	**−0.040***	0.007	−0.029	0.016	0.013
	(0.050)	(**0.078**)	(0.054)	(0.084)	(**0.009**)	(0.075)	(0.186)	(0.079)	(0.050)
Ez Tec	0.005	**0.209***	−0.039	**−0.262***	−0.022	−0.004	−0.053	0.016	0.005
	(0.169)	(**0.081**)	(0.173)	(**0.043**)	(0.068)	(0.200)	0.001	0.010	(0.169)
Panel B: other construction firms									
CR2	0.053	−0.013	0.035	−0.012	0.005	0.015	−0.001	−0.001	0.053
	(0.114)	(0.162)	(0.133)	(0.107)	(0.069)	(0.038)	(0.165)	(0.029)	(0.114)
Direcional	−0.041	0.022	0.042	−0.002	**−0.057***	0.011	**−0.046***	−0.002	−0.041
	(0.098)	(0.044)	(0.071)	(0.165)	(**0.013**)	(0.190)	(**0.020**)	(0.111)	(0.098)
Helbor	−0.026	0.030	**−0.103****	0.047	0.019	0.056	0.024	0.029	−0.026
	(0.195)	0.007	(**0.049**)	(0.050)	(0.151)	(0.089)	(0.126)	(0.180)	(0.195)
JHSF part	−0.017	0.001	−0.031	−0.015	**−0.223***	−0.034	**−0.057****	−0.022	−0.017
	(0.077)	(0.147)	(0.063)	(0.175)	(**0.059**)	(0.181)	(**0.039**)	(0.095)	(0.077)
Joao Fortes	0.001	0.025	−0.016	−0.005	−0.044	−0.001	−0.021	0.033	0.001
	(0.091)	(0.013)	(0.085)	(0.027)	0.005	(0.197)	(0.187)	(0.102)	(0.091)
Lix da Cunha	0.034	**0.124***	−0.052	0.003	−0.031	−0.043	0.018	−0.022	0.034
	(0.067)	(**0.046**)	(0.113)	(0.164)	(0.016)	(0.045)	(0.104)	(0.091)	(0.067)
Rossi	0.059	0.061	**−0.228***	−0.003	**−0.116***	−0.035	−0.014	−0.018	0.059
	(0.067)	(0.168)	(**0.074**)	(0.187)	(**0.037**)	(0.038)	(0.042)	(0.149)	(0.067)
Tecnisa	0.040	0.048	−0.031	0.006	−0.005	**−0.057***	0.017	−0.037	0.040
	(0.155)	(0.101)	(0.130)	(0.182)	(0.139)	(**0.028**)	(0.135)	(0.080)	(0.155)
Trisul	−0.064	0.019	−0.017	−0.108	0.008	−0.032	−0.035	0.018	−0.064
	(0.186)	(0.071)	(0.197)	(0.036)	(0.128)	0.005	(0.041)	(0.143)	(0.186)
Viver	−0.013	0.017	**−0.042***	0.010	0.041	−0.025	−0.011	0.045	−0.013
	(0.102)	(0.045)	(**0.000**)	(0.085)	(0.180)	(0.023)	(0.018)	(0.158)	(0.102)
Sultepa	−0.040	0.042	**0.039***	−0.006	0.031	0.064	−0.049	0.016	−0.040
	(0.123)	(0.053)	(**0.006**)	(0.087)	(0.027)	(0.127)	(0.118)	(0.015)	(0.123)

Table 6 reports changes in the CCC and its lags, revenue, and the combined effect on profitability, measured by Tobin's Q. Equation is $Ln(\Delta Q_t) = \beta_0 + \beta_1(\ln \Delta R_t) + \beta_2(lnDEBT_t) + \beta_3 \ln(\Delta CCC_t) + \beta_4 \ln(\Delta CCC_{t-1}) + \beta_5 \ln(\Delta CCC_{t-2}) + \beta_6 \ln(\Delta CCC_{u-3}) + \beta_7 \ln(\Delta CCC \Delta R_t) + Dummy + e_{it}$ The control variable is Debt. The dummy variable takes value 1 for every quarter after the second quarter of 2013. There are 29 observations for each company and variable, except for Brookfield, which has 25. There are 4923 total data points. Standard errors in parentheses. * and ** in bold represent significance at 5% and 10%, respectively.

Finally, we consider that state ownership may drive our results, and that x-inefficiency is related to state ownership. It is common for the state to have ownership stakes in listed companies in emerging markets. In Brazil, the state directly influences state-owned enterprises (SOEs) or indirectly through large stakes held by institutional investors such as development banks or the pension funds of SOEs. We found no evidence of state ownership, defined here as at least 10% of voting shares, of the companies in our sample.

5. Conclusion

In a world bereft with x-inefficiency there is a free lunch for all companies that do not manage their CCCs efficiently. Shortening the CCC, without affecting the operating margin or sales, increases profits, free cash flow to equity, and share prices. In this study, we formulate an approach to relate the CCC to enterprise value suitable to mature and stable companies. We assume a constant operating margin and arrive at a linear relationship that decomposes operating working capital (OWC) into revenue and CCC effects.

We document these effects by using direct and indirect evidence based on the case study of MRV, a listed real estate company in Brazil. We compare the company with its direct and distant competitors. The literature on the relationship between the CCC and profitability is well established. Nevertheless, most of the evidence for this relationship is indirect and captured by examining the impact of working capital variations on measures such as return on assets or Tobin's Q. Here, direct evidence comes from a specific program designed to decrease the CCC at MRV. The project started in early 2013, and through changes in processes related to purchasing and land registration, project design, financing, commercialization, and the registration of individual contracts,

the company reduced its CCC from 508 days in 2012 to 351 days in 2015, decreasing its working capital requirement by US$ 1.02 billion.

We propose a hypothesis based on theoretical considerations and the MRV case. For a stable business model, there is an optimal OWC equivalent to the least amount of cash necessary to generate sales, which is constrained by cost pressures and the possibility of losing customers. We provide indirect evidence that MRV's decrease in working capital requirements increased free cash flow as well as profits, and that it had a significant and positive effect on the stock price. For the first, we use a synthetic control using MRV's competitors; for the second, an event study; and finally, a restricted ADL framework in which we regress Tobin's Q on a modified version of the equation that decomposes OWC growth into the revenue and CCC effects, modifying Kroes and Manikas (2014). We find that the effect of the reduced CCC spreads over 24 months (the sample period is 2009–2015), and our results strongly suggest that improved WCM increases free cash flow to equity, stock prices, and profits. We thus corroborate Almeida and Eid's (2014) results, and reconcile most of the results linking WCM with shareholder value. For instance, our findings complement those of Ramiah et al. (2016), who explore the profile of working capital managers and find that a psychological evaluation of corporate treasurers is likely to boost efficiency in some specific areas of WCM. Moreover, managers that can tie OWC requirements to the rest of the firm's operations can identify sources of efficiency gains that can generate shareholder value with very little financial investments. Tying finance and operations through WCM is a promising area for increased shareholder return, something that seems underexplored in the financial and operations management literature.

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