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Weathering the Storm

Responses by Cambodian Firms to the Global Financial Crisis

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Abstract

Firms have various ways to cope with external risks. This paper analyzes the risk coping behavior that entails the smoothing of inputs (labor, raw materials, or capital). The theoretical framework shows that, if they face adjustment costs, firms prefer to smooth their inputs, especially if they expect a demand shock to be temporary. However, credit constrained firms will be adversely affected by the presence of liquidity constraints, and this will create a welfare loss due to incomplete smoothing. The authors estimate this behavior using a panel of Cambodian firms at the time of the 2008 global economic crisis. The survey shows that these firms were hard hit by the economic crisis between 2008 and 2009, with an average fall in demand (sales) of 30 percent. Based on the theoretical framework, the analysis can estimate the responsiveness of labor, capital, and raw materials input demand to demand shocks. It finds that firms try to smooth in particular if they believe the shock is temporary; in fact non-credit constrained firms reduce their inputs much less than firms that were credit constrained when the demand shock is expected to be temporary. The paper estimates that the welfare loss from incomplete smoothing due to credit constraints is many multiples of the adjustment costs of the firms that were not credit constrained. This has important policy implications about the role of financial sector development and regulations beyond the capital market. This micro analysis also has macro implications: if all firms expect a shock to be permanent, their combined limited smoothing of inputs will indeed make the shock more likely to be permanent.

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Weathering the Storm:
Responses by Cambodian Firms to the Global Financial Crisis

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1. Introduction

Many firms are vulnerable to large economic downturns as exemplified by the East Asian financial crisis and the ongoing global financial crisis. In times of crisis, many firms are forced to reduce investment, lay off workers, attract additional finance or even file for bankruptcy. However, the negative impact of a crisis is typically not uniform across firms, and can vary across firm characteristics such as size, industry, ownership structure, productivity, import and export orientation, and reliance on external finance (Dollar and Hallward-Driemeier 2000, Claessens *et* al 2000, Borensztein and Lee 2002, Narjoko and Hill 2007, Malouche 2009, Campello *et al.* 2010, Hallward-Driemeier and Rijkers 2011).

Importantly, economic policy-makers around the world have limited capacity to anticipate these large shocks, monitor their impact and formulate timely and effective policy responses. At one level the response has typically been macroeconomic, aiming at restoring macroeconomic stability and providing fiscal stimulus. At another level policy-makers have introduced microeconomic policies to help firms and workers cope with economic crises, for instance by facilitating access to credit, introducing temporary tax holidays and wage subsidies, and/or facilitate temporary reductions in the hours worked (Paci *et al*. 2009).

The need for and effectiveness of these policies in times of economic crises depend on the existing ability of firms and workers to cope with economic shocks. The issue has been extensively researched for households. Research shows that households in developing countries also face many risks and use many different ex ante and ex post risk coping strategies to reduce their vulnerability to risk (Morduch 1995, Dercon 2002, Skoufias and Quisumbing 2005). Following the seminal work of Townsend (1994), many studies on household vulnerability have been testing whether households are actually able to insure fully against the shocks they are facing and therefore to avoid the welfare loss associated with incomplete consumption smoothing（e.g. Paxson 1992, Jalan and Ravallion 1999, Gertler and Gruber 2002）.

Research on vulnerability and risk coping strategies of firms is much smaller, however (e.g. Greif 1993, Fafchamps 2000, Fafchamps *et al.* 2002, Khanna and Yafeh 2005). Also these studies have paid much less attention to the question to which extent firms are actually able to insure themselves against shocks, and the size of the welfare cost associated with imperfect risk coping in the presence of adjustment costs.

In this paper, we analyze risk coping behavior by firms in Cambodia following the global financial crisis. First, we develop a simple theoretical framework to analyze the welfare cost of imperfect risk coping in the presence of a large negative demand shock. Firms would prefer to reduce ('smooth') the downward adjustment of their use of inputs conditional on a negative shock in sales if they anticipate the downturn in sales to be temporary and if they face adjustment costs when changing input use. However, the actual ability of a firm to smooth (or hoard) inputs is adversely affected by the presence of liquidity or credit constraints, and the additional adjustment costs incurred by a liquidity constrained firm (relative to an unconstrained firms) can be used as an indicator of the welfare loss of incomplete risk coping. Next, we use the basic insights of the theoretical framework to analyze the adjustments in inputs by firms in Cambodia during the global financial crisis using panel data on firms for the period 2007-2009. We show that firms differed in terms of the degree to which they adjusted inputs, but that firms without credit constraints and expectations that the demand shock was temporary were much more able to smooth their use of inputs. Firms facing credit constraints, however, reduced inputs significantly even if they expected the downward shock to be temporary only.

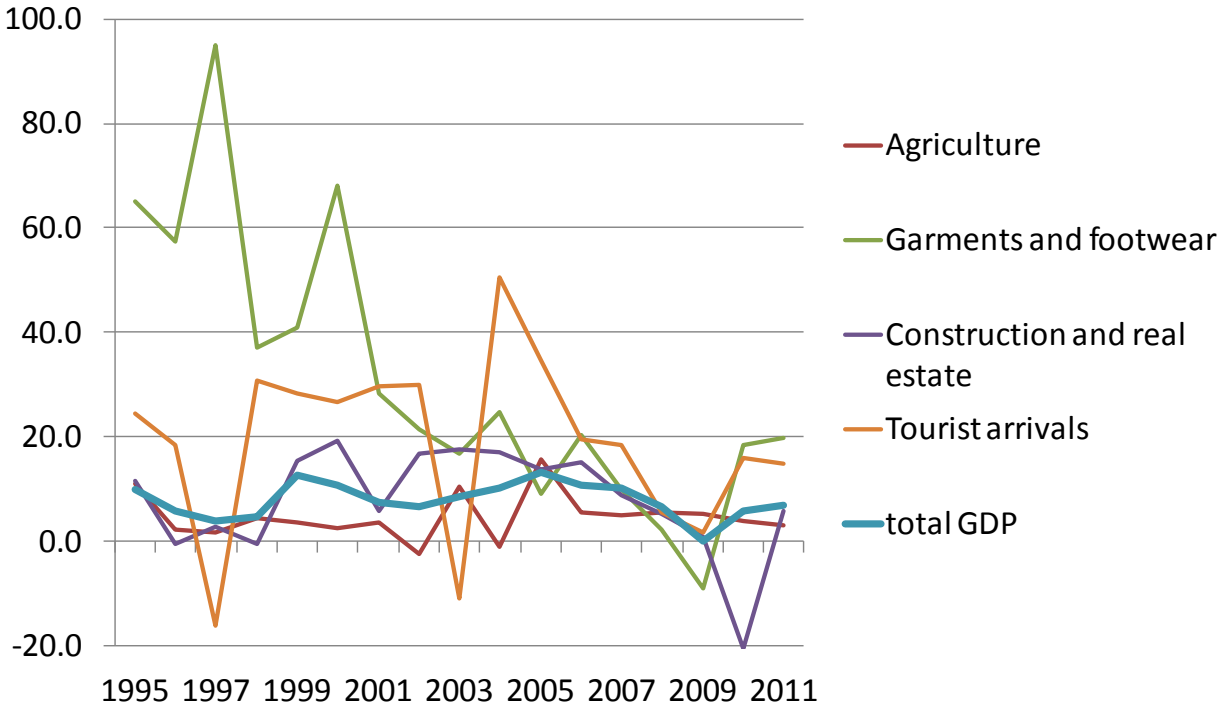
The paper is organized as follows. In section 2, we discuss the evidence on the impact of the global financial crisis on firms in Cambodia and their coping strategies. The impact of and response to the crisis has been highly heterogeneous at the firm-level. In section 3, we introduce a theoretical framework to explain why firms would like to smooth their input use in response to negative demand shocks, but are restrained to do so in the presence of credit constraints. In section 4, we analyze empirically the smoothing behavior of firms in Cambodia and show that firms differed in terms of the degree to which they adjusted inputs, particularly depending on the presence of credit constraints and their expectations on the duration of the negative shock. Also we estimate the welfare loss associated with incomplete input smoothing due to credit constraints. The final section concludes and discusses the policy implications of the analysis.

2. The impact of the global financial crisis on firms in Cambodia and their coping strategies

For Cambodia, the global financial crisis came in the backdrop of an episode of sustained rapid growth, essentially from the late 1990s when peace and political stability were achieved. The four key sectoral drivers of growth were garments, tourism, construction and agriculture. As a consequence, the growth process of the country was directly dependent on foreign demand (garments and tourism) and foreign

savings for investment (garment sector, construction and tourism). Of these four key drivers, agriculture had a relatively limited exposure to the crisis (Guimbert 2010). The next figure shows that after many years of high growth, the economy was strongly hit by the global financial crisis in 2008 with growth declining from 6.7% in 2008 to 0.1% in 2009. However, the negative shock was temporary as growth resumed quickly to 6.0% by 2010.

Figure 1: Cambodia GDP growth (%) – total economy and key sectors



Note: growth rates for GDP in 2000 constant prices, except 'tourist arrivals' (annual number of international visitors). Source: National Institute of Statistics, authors' calculation.

In this paper, we look at the responses of individual firms to the large negative shock between 2008 and 2009. For this, we use two firm surveys that were implemented respectively in August 2007 - March 2008 (Investment Climate Survey, ICS 2007/2008) and in July-November 2009 (the Cambodia Rapid Business Survey, CRBS 2009). Both surveys randomly sampled firms in Phnom Penh and in four other main cities in Cambodia (Battambang, Kampong Cham, Siem Reap and Sihanouk Ville). The sample was limited to firms in the formal sector that were registered with the Ministry of Commerce and which had at least five employees. Because no full census of establishments was available at the time, a sampling frame was constructed from the registry of firms maintained by the Ministry of Commerce, the registry of firms maintained by the Garment Manufacturers Association in Cambodia (GMAC), a list of tourism firms

provided by MPDF/IFC, a list of medium and large businesses provided by MPDF/IFC, as well as a census of firms with at most 50 employees done for the Provincial Business Environment Survey (PBES) in 2006.[2]

The total number of firms interviewed in the ICS 2007/2008 survey was 502. For the CRBS 2009 survey, all 502 firms of the 2007/2008 survey were re-contacted and information was collected on their activity status. A total of 89% of these firms were still found to be active while 10% of the firms were no longer active, for reasons of bankruptcy, seasonal inactivity, personal reasons (such as illness) or other.[3] Next, a random sample of 410 active firms was contacted to be interviewed again, creating a panel data set of 242 firms (positive response rate of 59%) with the 2007/2008 survey. In addition, 28 new (non-panel) firms were included in the sample to increase the number of large and exporting firms.[4]

While the first survey used a standard investment climate survey instrument collecting information on firm characteristics, firm productivity and investment climate constraints, the second survey was especially designed to capture the impact of the global crisis on Cambodia-based firms as well as their risk coping strategies.

Table 1 summarizes the main results with respect to the impact of the financial crisis on firm performance, input and output prices, employment and worker remuneration. The impact is wide-spread, with the vast majority of firms (80 to 90 percent) reporting a decrease in domestic sales and profits in the first half of 2009 compared to their situation in the first half of 2008. The mean decrease in domestic sales and profits was around 30 percent. The impact of the shock on exports was also significant, although slightly less. This shows that the financial crisis affected firms widely, and not only exporting firms were affected. The wide impact is also reflected in the macroeconomic assessment of a no-growth in 2009 (compared to rapid growth of almost 10 percent in 2000-2007, see Figure 1 above).

The profit squeeze is reflected in a decline in output prices of 6% on average without a corresponding decline in input prices (2% increase) over the same period. In terms of employment, the most affected were the unskilled production workers and non-production/service workers with declines of 3-4% on

[2] Both surveys were conducted by Indochina Research Ltd in Cambodia. The 2007 survey was financed by the World Bank and the 2009 survey by resources from DANIDA, the European Commission, and UNIDO under the Multi-Donor Trust Fund on Trade Related Assistance.

[3] 2% of the firms could not be found at the known address and may or may no longer be active.

[4] Because the 2009 survey was focused on the impact of the economic crisis, the sample was designed to include at least 100 exporting firms.

Table 1: Reported changes between January – June 2009 and the year before

	% firms reporting			Mean change reported (%)	Number of observations
	Decrease	No change	Increase		
Performance					
Total sales	85.4	9.2	5.4	-30.7	242
Domestic sales (if any)	85.3	9.1	5.6	-30.5	208
Exports (if any)	70.2	13.7	16.1	-14.5	65
Profits	88.5	4.8	6.7	-30.1	269
Prices					
Unit price of main product	38.6	47.4	14.0	-5.9	270
Unit price of main input	26.0	38.4	35.5	1.5	269
Permanent employment					
Total	16.6	68.6	14.7	-0.8	242
Management	5.3	90.2	4.5	-0.8	270
Professionals	11.0	74.6	14.4	+1.4	235
Skilled production workers	21.3	62.9	15.9	+3.3	84
Unskilled production workers	24.6	61.9	13.5	-3.0	71
Non-production/service workers	17.9	72.9	9.2	-4.2	251
Wages and compensation (permanent workers)					
Total	8.0	58.8	33.2	1.8	242
Management	4.9	70.3	24.8	2.2	270
Professionals	7.0	58.8	34.2	3.6	234
Skilled production workers	7.2	46.8	46.0	9.6	83
Unskilled production workers	4.6	72.8	22.6	2.7	70
Non-production/service workers	7.3	60.0	32.7	3.2	250

Note: all figures are weighted. Source: CRBS 2009.

average. Wages actually increased over the period and also increased in real terms (the inflation rate was -3.9% between July 2008 and July 2009 - World Bank 2009).

Although the financial crisis affected firms widely, the impact shows clear variation across firm characteristics. Table 2 reports descriptive OLS regressions to identify which firms are more likely to report larger changes in total sales and profits. We include controls for firm size, location, sector, labor productivity, export status and use of finance. Labor productivity is measured by value added per worker and medium and high productivity firms are those firms which have labor productivity levels in the second and third tercile of the productivity distribution. Use of finance indicates the source(s) of working capital used by the firm. Because the variables for export status and use of finance are only available in the ICS 2007/2008 survey, the regression is limited to the panel firms.

Table 2: Multivariate correlates of changes in sales and profits and bankruptcy

	Total sales (OLS)		Profits (OLS)		Bankruptcy (Probit, marginal effects)	
	(1)	(2)	(3)	(4)	(5)	(6)
Size (dummy - omitted: Small)						
Medium (20-99 workers)	5.23	5.28	5.88	**6.04**	0.020	0.025
	(3.73)	(3.72)	(3.68)	(3.65)	(0.028)	(0.027)
Large (at least 100 workers)	**10.4**	**9.37**	**11.0**	**10.0**	**0.074**	**0.064**
	(4.94)	(5.03)	(4.54)	(4.51)	(0.042)	(0.041)
Phnom Penh (dummy)	**24.1**	**24.7**	**18.9**	**19.6**	-0.020	-0.021
	(3.94)	(3.78)	(4.29)	(4.22)	(0.036)	(0.035)
Sector (dummy - omitted: Other manufacturing)						
Garments	-5.43	-5.68	5.98	5.81	-0.011	-0.012
	(9.67)	(9.64)	(8.88)	(8.77)	(0.030)	(0.026)
Trade	-1.95	-2.92	-3.33	-3.84	0.009	0.007
	(7.41)	(7.29)	(7.00)	(6.95)	(0.035)	(0.031)
Tourism	1.59	1.96	-4.35	-3.35	**-0.052**	**-0.047**
	(7.54)	(7.37)	(7.23)	(7.12)	(0.022)	(0.020)
Other	-2.62	-3.56	-1.97	-2.63	-0.023	-0.027
	(6.89)	(6.79)	(6.58)	(6.55)	(0.022)	(0.019)
Labor productivity (dummy - omitted: Low)						
Medium	4.22	3.65	5.39	4.90	**-0.056**	**-0.055**
	(3.43)	(3.42)	(3.56)	(3.56)	(0.019)	(0.018)
High	**10.5**	**9.86**	**12.4**	**11.5**	**-0.033**	**-0.030**
	(3.64)	(3.66)	(3.53)	(3.57)	(0.017)	(0.016)
Exporter (dummy)	-5.89	-5.39	**-22.2**	**-21.0**	0.030	0.032
	(8.26)	(8.26)	(7.34)	(7.36)	(0.032)	(0.031)
Use of finance (percent - omitted: Retained earnings)						
Formal institutions		**12.1**		**10.5**		-0.030
		(5.81)		(6.05)		(0.046)
Trade credit (suppliers/customers)		-3.65		4.79		0.054
		(7.38)		(7.45)		(0.037)
Informal		-1.47		-0.57		**-0.045**
		(3.75)		(3.49)		(0.023)
Constant	**-55.3**	**-55.2**	**-50.3**	**-51.2**		
	(8.10)	(7.91)	(8.03)	(7.93)		
Number of observations	231	231	231	231	453	453
(pseudo) R^2	0.21	0.22	0.21	0.22	0.15	0.18

Note: Huber/White/sandwich standard errors are reported in parentheses and coefficients which are significant at 10% are reported in bold.

Larger firms (above 100 workers) and more productive firms were more likely to weather the crisis, both in terms of changes in sales and changes in profits. On the other hand, smaller firms, those outside Phnom

Penh, exporting firms, and those with poor access to formal finance suffered more losses of sales and falls in profits. The deeper impact on the profits for less productive firms suggests a well-functioning market where more efficient firms weather downturns better than less efficient firms. The mechanism at play is that less efficient firms had to cut output prices to maintain market shares since they could not compete on quality, hence leading to a deeper impact on profits.[5]

Based on the CRBS 2009 survey, an estimated 4 percent of formal firms went bankrupt since the previous ICS 2007/2008 survey, with another 5 percent closing for seasonal or other reasons (weighted figures). The large number of bankruptcies is at odds with the lack of formal processes to close a business (in the "Doing Business" publication, Cambodia ranks 149 out 183 of countries in the 'resolving an insolvency' indicator, World Bank, 2011)). This suggests that a number of firms closed without due process (and with some overdue wage payments). In the garment sector, the likelihood of bankruptcy was 18.5 percent.[6] In columns (5) and (6) we report the marginal effects from a descriptive Probit regression for the probability that a firm went bankrupt between the 2007/2008 and 2009 surveys. Tourism businesses and more productive firms were less likely to go bankrupt, but larger firms were, surprisingly, more likely to go bankrupt. The higher bankruptcy rate for less efficient firms again suggests a well-functioning market. Firms relying more on informal finance were less likely to go bankrupt than firms relying on, especially, trade credit (which typically would be from suppliers or buyers, and hence disrupted by the crisis).

To put these data in perspective, we compare them to similar data from other countries (Table 3). Correa and Iootty (2010) collected data for 6 countries in Eastern Europe, using a similar survey methodology with a rapid firm survey following a larger survey the year before. The data show that in terms of sales all countries were strongly affected by the global financial crisis. In Cambodia, the percent of firms closed (3.9%) and declines in sales (-30.7%) were relatively high although not the highest. The employment impact in Cambodia has been limited, with relatively few firms (16.6%) reducing their number of permanent workers.[7] However, in terms of total change in employment (-0.8%), employment growth was only lower in Lithuania.

[5] We have run similar regressions for changes in output prices and find that firms in the bottom tercile of the productivity distribution cut their prices by 4% relative to firms in the top two terciles of the distribution.
[6] Weighted figure. This is in line with Ministry of Commerce data, showing that the number of factories declined from 308 in June 2008 to 257 in June 2009 (a fall of 16.3 percent; personal communication to the authors).
[7] Alternatively, the labor market adjustment could have been made on the wage side in Cambodia. However, survey data do not support that view.

Table 3: International Comparison of exit rates and changes in sales and employment during the global finance crisis

Indicators	Cambodia	Bulgaria	Hungary	Latvia	Lithuania	Romania	Turkey
Exit Rates							
% of firms closed	3.9	0.7	0.0	4.5	1.0	3.3	5.8
% of firms closed, insolvent, or impossible to locate	9.0	16.4	11.9	7.2	4.4	17.6	15.6
Sales							
% of firms with decreased sales	85.4	66.3	63.1	88.5	86.8	73.3	71.7
Change in sales (%)	-30.7	-20.5	-15.4	-41.1	-40.7	-25.2	-23.8
Labor							
% of firms that decreased their number of permanent workers	16.6	48.6	51.9	66.1	62.5	49.8	60.2
Change in permanent employment (%)	-0.8	5.4	28.6	-12.1	6.4	47.8	1.3

Note: Data from East Europe has a slightly different methodology, see Correa and Iootty (2010), and the comparison should be viewed as illustrative. Source: CRBS survey and ECA survey. Changes in sales and employment are for June of 2009 compared to the same month in 2008.

How did firms respond to this significant shock? In the CRBS 2009 survey, the Cambodian firms were asked about the actions taken in response to the financial crisis, such as increasing or decreasing sales prices, getting new loans, increasing or decreasing inventories, or developing new products. Because of the large number of actions possible, we grouped them into four types of responses, related to (1) production, (2) financing, (3) labor, and (4) management. In Table 4, we show the proportion of firms reporting any of these actions. We distinguish between firms that were credit constrained or not. A firm is classified as (increasingly) credit constrained, if it reported a change in the availability and/or cost of finance from at least one possible source (private commercial banks, state-owned bank or government, non-bank financial institution, credit from suppliers, advances from customers and informal sources (e.g. friends, family, money lenders), and not credit constrained otherwise.[8]

Firms have taken many different actions in response to the crisis, affecting production, finance, labor and management practices. For instance, 50% or more of all firms reduced sales prices, reduced inventory of finished products, looked for new customers / markets, looked for new finance and new business partners and developed / introduced new products / services. Also credit constrained firms were more likely to take action than firms that were not classified as credit constrained, particularly with respect to the inventory of raw materials, the search for new customers / markets, the use of trade credit from suppliers, the search for new finance and business partners, and the production capacity.

[8] In the survey firms were asked whether there was a change in the availability and/or cost of finance because of the economic crisis. Although it is conceivable that the constraints on finance eased, we assume that reported changes mostly reflected tightening of the financing conditions.

Table 4. Responses of firms to the global financial crisis (proportion of firms)

		Credit constrained		
	All	No	Yes	p-value
Production				
Reduce sales prices	0.51	0.49	0.52	0.59
Reduce input costs	0.23	0.26	0.21	0.34
Reduce inventory of raw materials	0.32	0.24	**0.38**	0.01
Reduce inventory of finished products	0.50	0.55	0.47	0.17
Looking for new customers / markets	0.83	0.77	**0.87**	0.03
Finance				
Reduce trade credit to customers	0.34	0.31	0.36	0.49
Increase trade credit from suppliers	0.18	0.10	**0.23**	0.01
Looking for new finance (formal/ informal sources)	0.80	0.70	**0.86**	0.00
Looking for new business partners	0.58	0.50	**0.63**	0.03
Labor				
Increase laying off workers	0.23	0.19	0.26	0.19
Reduce hiring workers	0.20	0.18	0.22	0.41
Reduce working hours / overtime per workers	0.11	0.10	0.11	0.72
Reduce wages per worker	0.10	0.09	0.10	0.71
Management				
Reduce production capacity	0.14	0.07	**0.19**	0.01
Reduce number of offices / branches / plants	0.05	0.04	0.06	0.45
Reduce investment	0.16	0.10	**0.20**	0.03
Exit product lines	0.14	0.10	0.17	0.11
Develop / introduce new products / services	0.62	0.60	0.64	0.50
Develop / introduce new technology	0.51	0.47	0.53	0.28
Intensify management (planning, review of budget and plan, etc.)	0.84	0.79	**0.87**	0.07

Note: the data are weighted. Mean responses which are larger and significantly different between firms that are and that are not credit constrained are reported in bold (at 10% significance level).

The table also suggests that credit constrained firms are more likely to reduce hiring and increase firing of workers (although the differences are not statistically significant in this bivariate comparison). This suggests that these firms are less able to hold on to their workers which could be costly if the negative shock is (expected to) be temporary. In the next section, we introduce a simple theoretical framework to show that the actual ability of a firm to smooth (or hoard) inputs is adversely affected by the presence of liquidity or credit constraints, and that this creates a welfare loss due to incomplete risk coping. Using this theoretical framework, we return to the survey data and analyze empirically whether credit constraints have indeed affected the ability of firms to smooth their labor (and other) inputs after the onset of the global financial crisis in Cambodia.

3. Demand shocks and input smoothing by firms

In this section, we develop a simple intertemporal framework to understand why firms can be expected to smooth temporary demand shocks. We keep the framework as simple as possible to bring out the main intuitions as why and under which circumstances firms would like to prefer to smooth their inputs. More complicated frameworks can be developed but are unnecessary to derive our main hypotheses for the ensuing empirical analysis.

Our interest in this paper is to analyze whether firms like to smooth in the presence of a large negative demand shock and how this desire is affected by the presence of a credit constraint. The desire to smooth in the wake of a negative shock derives from the presence of adjustment costs. Indeed, the predominant model in empirical and theoretical work on input smoothing (or dynamic factor demand) assumes that it is costly to adjust inputs. This model also assumes that these costs are symmetric and convex (quadratic) (Hamermesh and Pfann 1996). This implies that firms prefer many small adjustments over few large adjustments. We note that the assumption of convex adjustment costs has been criticized, however, as input dynamics often shows spikes or ' bunching' which are difficult to explain if adjustment costs are convex.[9] However, in our case, we are less interested in the path of adjustment over a given time period, rather than the input adjustment to a given shock. To keep the model simple, we use the predominant model of convex adjustment cost and test in the empirical analysis whether a flexible specification is needed to accommodate nonconvex adjustment costs to some extent.[10]

Assume that there are three periods, t=1,2,3. In each period t, the firm faces a demand y_t for its output which is produced with one single input x_t using a Cobb-Douglas production technology $y_t \leq Ax_t^{\alpha}$, with A total factor productivity and α the elasticity of output with respect to input. The firm can adjust its input between periods t=1 and t=2, and between t=2 and t=3, but this is costly (adjustment cost). The adjustment cost between period t-1 and t, C_t, is assumed to be quadratic in the size of adjustment relative to the input level in the previous period: $C_t = 0.5c(x_{t-1} - x_t)^2$, t=2,3, where c>0 is a constant.

[9] A number of alternative assumptions on the nature of adjustment costs, such as asymmetric convex costs, piecewise linear costs and lumpy costs have been introduced in the literature to better capture the path of input adjustment. However, it is still unclear whether there is an alternative adjustment cost model that captures the dynamics of input demand best (see Hamermesh and Pfann 1996 for a review).

[10] In particular, we will allow for a nonlinear effect of a demand shock on input smoothing, as a firm which faces fixed adjustment costs will not adjust inputs initially for small negative shocks, unlike a firm facing convex adjustment costs. We are grateful to Jeroen Pronk for pointing this possibility out to us.

The firm minimizes the cost of production subject to the constraint that the exogenously given demand for its output is met. For simplicity, we assume that the cost of a unit of input (w) is constant across periods and that there is no time discount. The optimization problem that is faced by the firm can therefore be written as:

$$\min_{x_1,x_2,x_3} \; wx_1 + wx_2 + wx_3 + 0.5c(x_1 - x_2)^2 + 0.5c(x_2 - x_3)^2$$
$$\text{s.t.} \qquad y_t \leq Ax_t^{\alpha} \quad t = 1,2,3$$

We note that the above model assumes that the firm cannot hold inventories. We make this assumption to keep the model simple but including inventories would not change the qualitative implications of the model (but it would make input smoothing less costly and therefore more likely if inventories can be held without significant cost).

The balance of this section derives a number of implications from this model for input smoothing by the firm under different scenarios: (i) stable demand; (ii) temporary shock; and (iii) permanent shock. We conclude the section by assessing the impact of a financial constraints on these adjustments.

Stable demand (baseline scenario)

We start the analysis with a situation where there is stable demand for the output of the firm: $y_1^{base} = y_2^{base} = y_3^{base} \equiv \bar{y}$. Alternatively, we could assume a constantly growing demand for output but this would complicate the analysis unnecessarily. The main idea is that before the outbreak of the global financial crisis that firms in Cambodia were generally enjoying predictable demand conditions and were making input and investment decisions accordingly.

With stable demand, the solution of the optimization problem is straightforward. Naturally, the firm will set its input use such that output equals demand in each period: $x_t = \left(\frac{\bar{y}}{A}\right)^{1/\alpha} \equiv \bar{x}$ and adjustment costs will be zero (given the simplifying assumption that the cost of input is constant). Suppose now that after period t=1 there is a negative demand shock. In this case it is intuitive that the firm will try to reduce its input level in period t=2 because of the unexpected fall in demand. However, whether and to which extent the firm will indeed reduce its input use will depend on a number of factors, particularly on the (perceived) persistence of the demand shock, the level of adjustment costs, and the availability of finance

for coping with risk. There are two possibilities in principle - either the demand shock is perceived to be temporary or it is perceived to be permanent. Of course, in practice a firm may perceive a shock to be both temporary (with a certain probability) as well as permanent (with the remaining probability), but in order to keep the analysis simple, we analyze both cases in turn.

Temporary demand shock

In this case, the demand falls unexpectedly after period *t*=1 but is expected to recover to the baseline level by period *t*=3 ($y_2^T < y_1^T = y_3^T = \bar{y}$). In order to analyze this and the following scenarios more carefully, we solve the optimization problem for periods *t*=2,3 formally using the Kuhn-Tucker optimization theorem. Let $\mathcal{L} = wx_2 + wx_3 + 0.5c(\bar{x} - x_2)^2 + 0.5c(x_2 - x_3)^2 + \sum_{t=2}^{3} \lambda_t (y_t - Ax_t^{\alpha})$ be the Lagrangian with $\lambda_t \geq 0$ the Kuhn-Tucker multipliers for the inequality constraints. The first-order conditions are

(1) $$\frac{\partial \mathcal{L}}{\partial x_2} = w - c(\bar{x} - x_2) + c(x_2 - x_3) - \lambda_2 \alpha A x_2^{\alpha - 1} = 0$$

(2) $$\frac{\partial \mathcal{L}}{\partial x_3} = w - c(x_2 - x_3) - \lambda_3 \alpha A x_3^{\alpha - 1} = 0$$

We note that always $\lambda_3 > 0$ (the inequality constraint $y_3 \leq Ax_3^{\alpha}$ holds with equality) because there is no benefit for the firm to use more input than necessary in period 3 (because it would increase input costs *and* adjustment cost given that $x_2 \leq x_3$). Hence $x_3^T = \bar{x}$. There are now two possible cases, namely the firm does not smooth (or hoard) inputs in period 2 (the constraint $y_t - Ax_t^{\alpha} \leq 0$ is binding and $\lambda_2 > 0$) or the firm does smooth inputs in period 2 (the constraint $y_t - Ax_t^{\alpha} \leq 0$ is nonbinding and $\lambda_2 = 0$):

- If the firm does not smooth (or hoard) inputs in period 2, then it uses just enough inputs to produce the required output y_2^T. Hence, $x_2^T = \left(\frac{y_2^T}{A}\right)^{1/\alpha} \equiv \bar{x}_2^T$.
- In the case that the firm smoothes inputs in period 2, the first-order conditions imply that $x_2^T = \bar{x} - \frac{w}{2c}$ (because $\lambda_2 = 0$).

Whether the firm smoothes inputs depends on the size of the adjustment cost. Let c^* be the adjustment cost where the production constraint is just binding in period 2: [11]

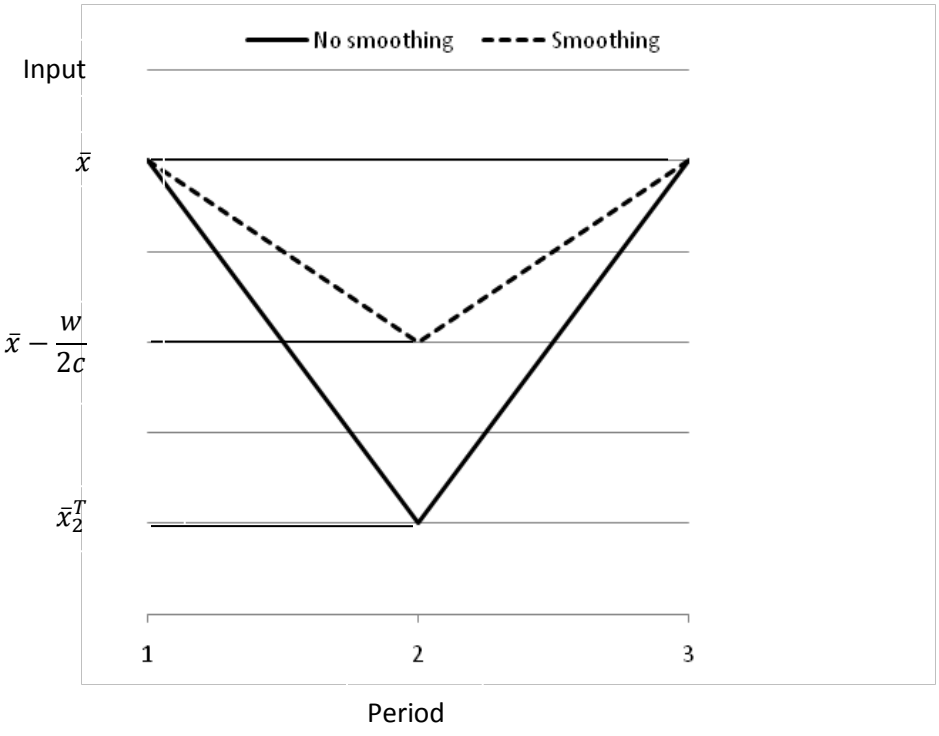
$$c^* = \frac{w}{2(\bar{x} - \bar{x}_2^T)}$$

The optimal choice of inputs for the firm is then given by

(3) $$x_2^T = \begin{cases} \bar{x}_2^T & c \leq c^* \\ \bar{x} - \frac{w}{2c} & c > c^* \end{cases}$$

Hence, for small enough adjustment costs, the firm will reduce inputs fully in period 2 following the negative demand shock ($y_2 = Ax_2^{\alpha}$), while for high adjustment costs the firm will reduce inputs only partially ($y_2 < Ax_2^{\alpha}$). These two cases are illustrated in Figure 2.

Figure 2. Smoothing of inputs after temporary shock in demand



[11] This is the *c* such that $\bar{x}_2^T = \bar{x} - \frac{w}{2c}$.

It is also clear that the threshold for adjustment (c^*) will be higher the higher is *w* and the lower the gap between $\bar{x}$ and $\bar{x}_2^T$. Hence, input smoothing is more likely to occur ($c > c^*$) if input costs are low or the reduction in demand is large. And given that the firm smoothes inputs, the extent of smoothing is larger ($\bar{x} - \frac{w}{2c}$ is larger) if input costs (*w*) are low and adjustment costs (*c*) high.

Permanent demand shock

In this case, demand falls unexpectedly after period *t*=1 and is not expected to recover to the baseline level by period *t*=3 ($y_2^P = y_3^P < y_1^T = \bar{y}$). In order to make the analysis comparable to the temporary demand shock scenario, we assume that the fall in demand is the same ($y_2^P = y_2^T$).

Based on the first-order conditions we can distinguish between different cases:

- The first case is where the firm does not smooth inputs in periods 2 and 3 ($\lambda_2 > 0$ and $\lambda_3 > 0$). In this case, $x_2^P = x_3^P = \left(\frac{y_2^P}{A}\right)^{1/\alpha} = \bar{x}_2^T$, that is, the firm lowers the inputs in period 2 fully and keeps this low level of inputs in period 3.
- The second case is where the firm smoothes inputs in period 2, but not in period 3 ($\lambda_2 = 0$ and $\lambda_3 > 0$). Solving the first-order conditions in this case gives us $x_2^P = \frac{\bar{x}+\bar{x}_2^T}{2} - \frac{w}{2c}$ and $x_3^P = \bar{x}_2^T$.
- A third case occurs if the firm smoothes inputs both in periods 2 and 3 ($\lambda_2 = 0$ and $\lambda_3 = 0$). If one solves the first-order conditions for this case, we get the optimal inputs for the firm, $x_2^P = \bar{x} - \frac{2w}{c}$ and $x_3^P = \bar{x} - \frac{3w}{c}$..

Once again, whether the firm smoothes inputs in period 2 and 3 depends on the size of the adjustment cost. Let c^{**} be the adjustment cost where the production constraint is just binding in period 2:[12]

$$c^{**} = \frac{w}{\bar{x} - \bar{x}_2^T} = 2c^*$$

If the adjustment cost exceeds c^{**}, then the firm would like to smooth inputs in period 2. Note that $c^{**} = 2c^*$, and therefore the adjustment cost needs to be higher to induce smoothing in the case of a

[12] This is the *c* such that $\bar{x}_2^T = \frac{\bar{x}+\bar{x}_2^T}{2} - \frac{w}{2c}$.

permanent shock compared to a temporary shock.

Let c^{***} be the adjustment cost where the production constraint is just binding in period 3:[13]

$$c^{***} = \frac{3w}{\bar{x} - \bar{x}_2^T}$$

If the adjustment cost exceeds c^{***}, then the firm would like to smooth inputs in period 3. Note that $c^{***} = 3c^{**}$, and therefore the adjustment cost needs to be much higher to induce smoothing in both period 2 and 3 than only in period 2.

We can now characterize the optimal input choice of the firm:[14]

$$x_2^P = \begin{cases} \bar{x}_2^T & c \leq 2c^* \\ \frac{\bar{x} + \bar{x}_2^T}{2} - \frac{w}{2c} & 2c^* < c \leq 6c^* \\ \bar{x} - \frac{2w}{c} & c > 6c^* \end{cases}$$

(4)

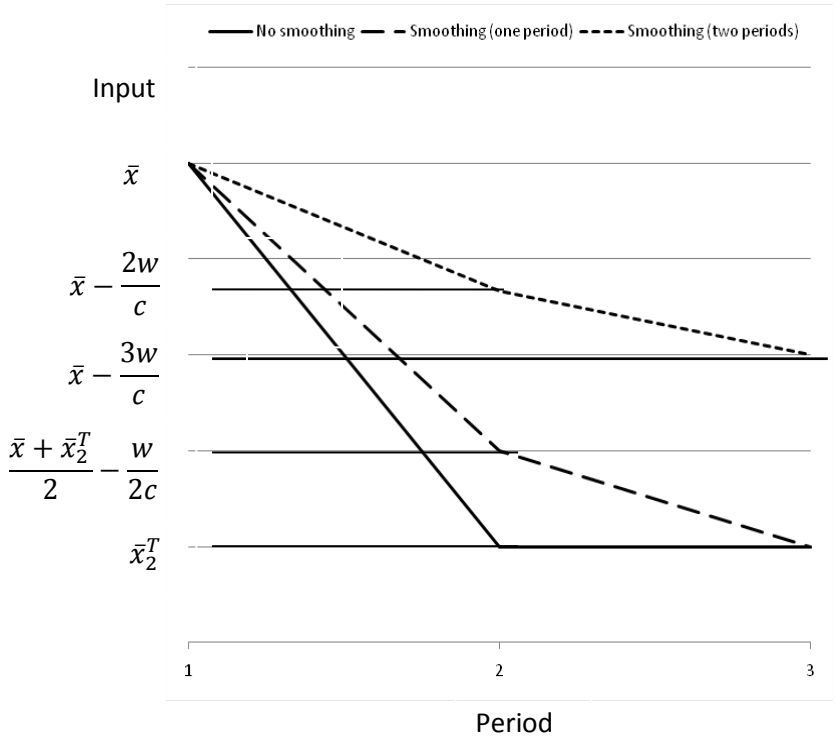
$$x_3^P = \begin{cases} \bar{x}_2^T & c \leq 6c^* \\ \bar{x} - \frac{3w}{c} & c > 6c^* \end{cases}$$

Figure 3 illustrates the optimal choice of the firm. Similarly to the case of a temporary demand shock, input smoothing is more likely to occur ($c > c^{**}$ and/or $c > c^{***}$) if input costs are low or the reduction in demand is large. And given that the firm smoothes inputs, the extent of smoothing is larger if input costs (w) are low and adjustment costs (c) high. Finally, as shown above, smoothing is less likely to occur with a permanent than a temporary demand shock. And, if the firm smoothes, the extent of smoothing is smaller with a permanent than a temporary shock (because both $\frac{\bar{x}+\bar{x}_2^T}{2} - \frac{w}{2c} < \bar{x} - \frac{w}{2c}$ and $\bar{x} - \frac{2w}{c} < \bar{x} - \frac{w}{2c}$).

[13] This is the c such that $\bar{x}_2^T = \bar{x} - \frac{3w}{c}$.

[14] These three cases characterize all the possible optimal input allocations because no firm will like to smooth in period 3 but not in period 2 ($\lambda_2 > 0$ and $\lambda_3 = 0$). This is not optimal because there is no benefit for the firm to use more input than necessary in period 3 (it would increase input costs *and* adjustment cost given that $x_2 < x_3$).

Figure 3. Smoothing of inputs after permanent shock in demand



Financial constraint

In the analysis so far, we have assumed that the firm does not face a financial constraint when smoothing (or hoarding) inputs. Smoothing inputs, however, will increase the cost in period 2 and therefore the (internal or external) financing need of the firm. This can be seen as follows. The total cost in period 2 is given by $C_2 = wx_2 + 0.5c(\bar{x} - x_2)^2$. The marginal cost of increasing the input by one unit is then $\frac{\partial C_2}{\partial x_2} = w - c(\bar{x} - x_2)$. Using the first-order condition (1), it follows that $\frac{\partial C_2}{\partial x_2} = c(x_3 - x_2)$ if the firm smoothes inputs in period 2 ($\lambda_2 = 0$). Hence, $\frac{\partial C_2}{\partial x_2} > 0$ for a firm that smoothes inputs and which expects the demand shock to be temporary ($x_2 < x_3$). In other words, a firm which smoothes inputs and which expects the shock to be temporary can reduce its costs in period 2 by smoothing less. The reason for this is intuitive – part of the benefit from input smoothing materializes after period 2 in the form of reduced adjustment costs (in period 3).

Hence, if a firm faces a financial constraint in period 2, it will be willing to smooth less in the presence of a temporary shock. This has an interesting empirical implication for the analysis in the next section: in

general we expect firms that are more positive about the future (i.e. that expect the negative demand shock to be temporary) to smooth more (as we saw before). But among the firms that are positive about the future, the firms with a credit constraint will tend to smooth less.[15]

In the next section, we use the above framework to analyze the input smoothing behavior of Cambodian firms during the global financial crisis.

4. Input smoothing by Cambodian firms during the global financial crisis: Empirical analysis

As shown in section two, the global financial crisis affected Cambodian firms strongly on the demand side with a strong contraction in both foreign and domestic demand. The theoretical framework developed in the previous section suggests that firms adjust their inputs when faced with a demand shock, but that the size of the adjustment depends a number of critical variables, particularly the size of the adjustment costs, the price of inputs, the size of the demand shock, the persistence of the shock, and the availability of finance.

Let ΔX_{it} be the change in input use by firm *i* in between period *t-1* and *t*. In our empirical model, we specify the change in input use as a function of the demand shock and, possibly, of other factors (such as price changes):

$$\Delta X_{it} = \alpha + \beta \Delta Y_{it} + Z_{it}\gamma + \varepsilon_{it} \quad (5)$$

where ΔY_{it} is the demand shock, Z_{it} a vector of other variables that may affect changes in input use, and ε_{it} an unobserved error term. The parameter β in equation (5) provides an estimate of the extent to which demand shocks play a significant role in explaining changes in firm-level input use. In particular, β is expected to be smaller when the firm is smoothing more, that is, when the adjustment cost is larger, the price of inputs lower, the demand shock higher, and the persistence of the demand shock lower. Also if the demand shock is expected to be temporary, then less availability of finance is expected to increase β.

[15] Note that the model also implies that $\frac{\partial C_2}{\partial x_2} < 0$ if the demand shock is permanent and the firm smoothes in period 2 ($x_3 < x_2$). This suggests that a credit constrained firm that smoothes inputs and which expects the shock to be permanent will like to *increase* smoothing. Although this is a theoretical possibility, in the empirical analysis in the next section we do not find an impact from credit constraints on smoothing behavior for firms that expect the shock to be permanent. This is not inconsistent with the model, because this theoretical implication concerns only firms that are smoothing, and smoothing is much less likely to occur for permanent shocks (as discussed above).

Therefore in the analysis we will allow the parameter β to vary across different types of firms and inputs. Also we will allow for a nonlinear effect of a demand shock on input smoothing by including a quadratic term $(\Delta Y_{it})^2$ in the above equation, as a firm which faces fixed adjustment costs will not adjust inputs initially for small negative shocks, unlike a firm facing convex adjustment costs.

Smoothing of labor inputs

Different versions of the empirical model will be estimated for different indicators of input use. We start with the use of labor inputs. As already presented in Table 1, the CRBS 2009 survey asked the firm by which percentage the number of permanent workers had increased relative to the same period one year before.[16] On average, firms reduced the number of workers. However, most notable is that the firms reduced the input use of unskilled production and non-production workers much more than that of managers, professionals and skilled production workers. This may reflect differences in adjustment costs, as the hiring and firing of skilled workers is typically more costly than that of unskilled workers (Hamermesh and Pfann 1996).

In order to understand to which extent the changes in labor input use are the result of demand shocks, we first estimate model (5) for reported changes of each type of labor input controlling for the demand shock as experienced by the firm. The demand shock is measured as the percentage change in the firm's total sales (domestic and foreign) in the period since one year ago. In terms of the vector Z_{it}, we include dummies for the type of labor, sector, firm size and location. These dummies control for factors that affect the (relative) adjustments of each type of labor, such as differences in labor-output elasticity across type of labor, changes in relative prices of types of labor, and changes in raw materials and output prices. In the subsequent analysis we will also present estimates where we allow the regression coefficients (and specifically β) to vary by skill type of worker (see Table 6).

Column (1) of Table 5 presents the results of the regression. The standard errors are corrected for clustering at the firm level and t-values are reported in parentheses.[17] There is a positive correlation between the percentage change in permanent workers and the percentage change in sales. The coefficient

[16] Of course firms may also employ temporary workers next to permanent workers. However, in Cambodia, the percentage of temporary workers is only 3.6% of total employment. Consequently, few firms report changes in the number of temporary workers and therefore the analysis focuses on permanent workers only.
[17] A firm can have multiple observations if it employs different types of labor.

is 0.15, i.e. a 30.7% reduction in sales (the observed mean change) would imply an average decline of permanent workers of -4.6%. However, the dummies for types of labor confirm that production and non-production workers saw a much larger decline in employment.

The sector dummies are jointly significant at the 10% level and show that the downward adjustment was the strongest in the manufacturing, garments and trade industries. The size dummies are both individually and jointly insignificant, showing that firms of all size were affected equally by the economic crisis (ceteris paribus).

The model in the previous section shows that firms will be more likely to smooth the use of inputs if they expect the demand shock to be temporary. Therefore we next include an interaction term between the demand shock and a dummy variable whether the firm expects the demand shock to be temporary in the regression model (5). The firms have been asked about their prediction for the workforce in the next 12

Table 5. OLS Regression of percentage change in permanent workers on demand shock

	(1)	(2)	(3)	(4)
			Credit constrained	
Demand shock			No	Yes
Change in sales (%)	**0.15** (3.76)	**0.14** (3.26)	**0.13** (1.94)	**0.13** (2.42)
Change in sales x temporary (%)		0.02 (0.42)	**-0.10** (1.74)	0.10 (1.40)
Type of labor (omitted: managers)				
Professionals	1.38 (1.03)	1.40 (1.04)	-0.77 (0.37)	**2.83** (1.63)
Skilled production workers	-2.00 (0.84)	-2.00 (0.84)	-3.56 (1.65)	-1.05 (0.29)
Unskilled production workers	-3.97 (1.45)	-3.97 (1.46)	-1.98 (0.92)	-5.30 (1.22)
Non-production/service workers	**-2.89** (2.45)	**-2.89** (2.44)	**-4.55** (2.78)	-1.87 (1.13)
Sector (omitted: (Other) manufacturing)				
Garments	0.68 (0.19)	0.61 (0.17)	3.17 (0.58)	2.25 (0.45)
Trade	-1.48 (0.38)	-1.44 (0.38)	-2.76 (0.66)	2.35 (0.41)
Tourism	5.41 (1.53)	5.39 (1.53)	3.23 (1.04)	8.28 (1.53)
Other	4.54 (1.39)	4.51 (1.38)	2.95 (1.04)	6.83 (1.57)
Size (omitted: Small)				
Medium	-2.62 (1.39)	-2.72 (1.44)	-0.31 (0.11)	-3.19 (1.21)
Large	-3.77 (1.22)	-3.82 (1.22)	-0.29 (0.09)	-3.87 (0.84)
Phnom Penh (dummy)	-1.93 (0.54)	-1.79 (0.52)	-0.46 (0.10)	-2.02 (0.40)
Constant	5.26 (1.01)	5.25 (1.02)	1.86 (0.32)	3.77 (0.48)
Number of observations	802	802	322	480
R^2	0.09	0.09	0.09	0.13

Note: standard errors are clustered at the firm level and t-values are reported in parentheses. Coefficients which are significant at 10% are reported in bold.

months and for all firms that indicated that it expected to increase the workforce 'somewhat' or 'drastically', the demand shock was classified as temporary. Given that temporary shocks are more likely to be smoothed, the coefficient for this interaction term is expected to be negative. Column (2) in Table 5 reports the results. The interaction term is not different from zero and therefore firms which expect the shock to be temporary do not smooth more than the other firms. This result is not different if we include also a dummy variable for temporary demand shock to control for possible unobserved differences between firms with different expectations (the dummy variable turned out to be insignificant and was therefore excluded).

However, the model in section 2 also suggests that firms that are credit constrained will smooth less than firms that are not credit constrained. We therefore re-estimate the regression in column (2) but now for two types of firms separately – credit constrained or not. A firm was classified as (increasingly) credit constrained, if it reported a change in the availability and/or cost of finance from at least one possible source (private commercial banks, state-owned bank or government, non-bank financial institution, credit from suppliers, advances from customers and informal sources (e.g. friends, family, money lenders)), and not credit constrained otherwise. Columns (3)-(4) report the results.

For permanent shocks we do not observe a difference between firms that are credit constrained and that are not credit constrained (coefficient 0.13). But for the temporary shocks we see a clear difference – firms that are not credit constrained reduce their labor input less for a given negative sales shock (combined coefficient of 0.03) than firms that are credit constrained (combined coefficient of 0.23). Also this difference is statistically significant at 10% (p-value 0.03). Hence, credit constraints reduce the smoothing of labor inputs.[18]

Firms reduced their input of unskilled labor (unskilled production and non-production / service workers) more than their skilled labor input (managers, professionals and skilled production workers). Research suggests that the average cost of adjustment rises "very rapidly with the skill of the worker" (Hamermesh and Pfann, 1996, p.1268). This implies that firms will like to hold on to their skilled workers more than to

[18] The fact that we find a difference in smoothing of temporary shocks but not for permanent shocks between firms that are and that are not credit constrained is actually not inconsistent with the theoretical model. This situation is possible if $c^* \leq c \leq 2c^*$ because then a firm will smooth temporary shocks but not permanent shocks. Also in the latter case there is an incentive to decrease smoothing (reduce inputs further) with a credit constraint ($\frac{\partial C_2}{\partial x_2} = \lambda_2 \alpha A x_2^{\alpha-1} > 0$ because $\lambda_2 > 0$ and $x_2^P = x_3^P$), but this is not feasible because the constraint $y_2 - A x_2^{\alpha} \leq 0$ is already binding.

their unskilled workers following a negative demand shock, especially if they expect this demand shock to be temporary. This suggests that the parameter β also varies across the skill type of the worker, with a smaller coefficient for skilled workers. We have therefore rerun the same regressions as in Table 6, but now for skilled and unskilled workers separately. In order to save space, we only report the estimated values for β in the next table.

The results confirm the conjecture – the parameter β is estimated to be larger for unskilled than for skilled workers across all specifications, suggesting that adjustment costs are indeed higher for skilled than for unskilled workers.[19] Also the results for skilled and unskilled workers show otherwise the same pattern as in Table 5[20] – firms tend to reduce their labor inputs, but they do this less if they expect the downturn to be temporary.

Table 6. OLS Regression of percentage change in permanent workers on demand shock by skill type of worker

	(1)	(2)	(3)	(4)
			Credit constrained	
Skilled workers			No	Yes
Change in sales (%)	**0.13** (3.38)	**0.13** (3.15)	0.11 (1.36)	**0.13** (2.68)
Change in sales x temporary (%)		0.00 (0.07)	-0.08 (1.26)	0.06 (0.93)
Number of observations	518	518	207	311
R^2	0.08	0.08	0.07	0.11
Unskilled workers				
Change in sales (%)	**0.19** (3.18)	**0.17** (2.40)	**0.19** (2.33)	0.14 (1.48)
Change in sales x temporary (%)		0.06 (0.74)	**-0.14** (1.74)	0.18 (1.64)
Number of observations	284	284	115	169
R^2	0.13	0.13	0.28	0.17

Note: the regressions also include the same control variables as in Table 5. Standard errors are clustered at the firm level and t-values are reported in parentheses. Coefficients which are significant at 10% are reported in bold.

Before turning to inputs other than labor, we explore two potential caveats: the convexity of adjustment shocks and the potential endogeneity bias between inputs and outputs. We first check whether there is a nonlinear relationship between changes in input (here: labor) demand and a demand shock. If the

[19] However we cannot exclude the possibility that this (also) reflects differences in bargaining power – skilled workers may have more insider power than unskilled workers and may resist lay-offs more successfully (at least initially).

[20] Although the estimated coefficients are less significant because of smaller sample sizes.

adjustment costs include a fixed cost, then firms may react to a demand shock only if it is sufficiently large. In that case we expect the parameter β to be zero for small demand shocks, and to be positive for larger shocks. We have therefore also run the above regressions including quadratic terms for the demand shock variables (results not reported). We do not find them to be significant, however, suggesting that fixed costs do not drive the adjustment pattern in labor inputs.

Then we also check whether the above results suffer from an endogeneity bias because firms that reduce labor inputs will also tend to reduce sales because of a reduction in output. However it should be noted that we are primarily interested in the *relative* impact of demand shocks – comparing temporary versus permanent shocks or demand shocks in credit constrained firms versus in firms that are not credit constrained. Although endogeneity bias will lead to an overestimate of the absolute impact of demand shocks, there is no a priori expectation whether and in which direction there would be a bias in the relative size of the impact across different shocks and firms due to endogeneity. Moreover, because we analyze the impact of (first) differences in sales on differences in inputs, all time-invariant firm-level (and labor type-level) factors affecting the level of sales and inputs are controlled for. Most interestingly, however, we expect endogeneity bias to be of even a less concern in case the firm applies input smoothing after a sales shock. In this case, if inputs are unexpectedly low for an unobserved reason, this will not affect total sales because the production constraint is non-binding ($\lambda_2 = 0$ in the model of section 3). We therefore expect that endogeneity bias, if present, will be more of a concern for credit-constrained firms than for firms that are not credit constrained.

We therefore also estimate the model with instrumental variables in order to control for possible endogeneity bias. As instruments for the demand shock, we use the information on exporting behavior from the pre-crisis ICS 2007 survey as (pre-crisis) international exposure will most likely have affected the extent to which a firm has been affected by the global financial crisis. We include three proxies for pre-crisis international exposure, namely the percentage of sales that the firm exported in 2007, the destination of these exports in 2007 (USA, EU or other international destination) and the first year of exporting (before 2000, between 2000 and 2003, and after 2003). Because we use these instruments for both the sales shock and its interaction with the dummy variable for temporary demand shock, these instruments are also interacted with this dummy variable.

Table 7. IV regression of percentage change in permanent workers on demand shock

	(1)	(2)	(3)	(4)
			Credit constrained	
Demand shock			No	Yes
Change in sales (%)	**0.18** (1.81)	**0.18** (1.86)	0.05 (0.52)	**0.33** (2.62)
Change in sales x temporary (%)		0.00 (0.04)	**-0.13** (1.98)	0.05 (0.65)
Type of labor (omitted: managers)				
Professionals	1.35 (1.00)	1.34 (1.00)	-0.78 (0.38)	2.47 (1.46)
Skilled production workers	-2.00 (0.85)	-2.00 (0.85)	**-3.56** (1.69)	-1.02 (0.28)
Unskilled production workers	-4.02 (1.48)	-4.02 (1.47)	-1.80 (0.83)	-5.52 (1.25)
Non-production/service workers	**-2.90** (2.47)	**-2.90** (2.47)	**-4.56** (2.86)	-2.00 (1.22)
Sector (omitted: (Other) manufacturing)				
Garments	0.41 (0.11)	0.42 (0.12)	4.40 (0.78)	0.13 (0.03)
Trade	-1.87 (0.46)	-1.86 (0.46)	-1.58 (0.36)	-0.68 (0.11)
Tourism	5.16 (1.46)	5.17 (1.46)	3.59 (1.10)	5.89 (1.15)
Other	4.19 (1.24)	4.20 (1.24)	4.84 (1.33)	4.82 (0.98)
Size (omitted: Small)				
Medium	-2.75 (1.44)	-2.74 (1.41)	0.45 (0.16)	-3.97 (1.35)
Large	-4.07 (1.31)	-4.06 (1.29)	1.10 (0.29)	-5.71 (1.21)
Phnom Penh (dummy)	-2.71 (0.60)	-2.71 (0.61)	1.76 (0.33)	-6.88 (1.00)
Constant	7.16 (0.90)	7.13 (0.87)	-3.94 (0.45)	15.52 (1.37)
Underidentification test (p-value)[a]	22.2 (0.18)	19.1 (0.27)	9.82 (0.63)	13.5 (0.63)
Weak identification test (10% critical value)[b]	4.42 (3.24)	4.55 (3.55)	14.1 (3.56)	6.27 (3.55)
Overidentification test (p-value)[c]	15.3 (0.51)	15.2 (0.44)	10.6 (0.47)	15.5 (0.42)
Endogeneity test (p-value)[d]	0.04 (0.85)	0.92 (0.63)	0.12 (0.94)	3.20 (0.20)
Number of observations	802	802	322	480
R^2	0.09	0.09	0.07	0.07

Note: standard errors are clustered at the firm level and t-values are reported in parentheses. Coefficients which are significant at 10% are reported in bold. [a] Kleibergen-Paap LM statistic. [b] Kleibergen-Paap Wald F-statistic with Stock-Yogo weak ID test critical values for 10% maximal LIML size. [c] Hansen J-statistic. [d] Hausman specification test.

Table 7 presents the results of the instrumental variable regressions. We have estimated the regressions with limited information maximum likelihood because LIML is more robust than 2SLS in the presence of weak instruments (Stock and Yogo 2002). The tests on under- and weak identification as well as over-identification are all passed without difficulty at the 10% level. The Hausman specification test for endogeneity suggests that there is no significant bias in the OLS estimates.

It is therefore not surprising that the results in the IV regressions are very similar to those in the OLS regressions. Also now we find that firms will tend to smooth inputs more if they are not credit constrained

and if they expect the shock to be temporary. Hence we conclude that an endogeneity bias is probably less of a concern in our analysis.

Smoothing of capital inputs

Apart from smoothing (or hoarding) the use of labor inputs, one may ask whether firms do also smooth other types of inputs that are costly to adjust. Another important input is of course capital. Firms have been asked whether they reduced, kept the same, or increased their capacity for production, where capacity is defined as the ability to produce with the existing machinery and equipment and regular shifts. We would expect that firms that expect the sales shock to be temporary to be less likely to reduce their capacity, especially if they are not credit constrained. We therefore re-estimate equation (5) but now for the change in capacity since the beginning of the crisis. The equation is estimated as an ordered logistic regression because of the ordered nature of the dependent variable with three outcomes, namely 'reduce', 'same', and 'increase'.

Columns (1)-(2) in Table 8 report the results for firms according to whether they are credit constrained or not.[21] Firms that are not credit constrained reduce their capacity after a negative demand shock but only if they expect the demand shock to last (column 1). Because the coefficients cannot directly be interpreted as marginal effects in a ordered logit model, we also calculated marginal effects on the probability that the capacity is increased (evaluated at the means of the independent variables). The estimated coefficients imply that a permanent sales shock of -30% increases the probability of capacity reduction by 12%, while a similar temporary shock increases this probability by only 1% For firms that are credit constrained, however, we do not find a significant different response to permanent and temporary shocks (column 2). We note that this is exactly the pattern which we observed for the use of permanent labor and also in line with the predictions of the model in section 3. With respect to the other firm characteristics, we do not observe different capacity adjustments across sector, firm size and location.

We have cross-checked this result by looking at the actual change in capacity utilization by firms in 2007 versus 2009. Because the question on actual capacity utilization was only answered by manufacturing firms, the number of observations is only about 60. Nevertheless we also find that firms tend to reduce

[21] Once again, we have also included a separate dummy for temporary shock but this dummy was found to be insignificant and does not affect the results.

their capacity after a sales shock, but much more strongly if the shock is considered to be temporary (results not reported).

Smoothing of raw materials

We finally look at another type of input, namely raw materials. In the survey, firms have not been asked about changes in the use of raw materials but they were asked whether they have reduced, kept the same, or increased their inventory of raw materials since the beginning of the global financial crisis. If a firm smoothes the use of raw materials, then we expect the inventory of raw materials to increase. Therefore, firms which are not credit constrained and which expect a negative demand shock to be temporary are expected to reduce their inventory of raw materials less than otherwise similar firms. Column (3) of Table 8 shows that this is indeed the case. When we calculate the marginal effects of a negative demand shock of 30%, we find that the probability that a firm increases its inventory of raw materials is reduced by 5%.

Table 8. Ordered logistic regression of the change in capacity and inventories of raw materials on demand shock

	Change capacity?		**Change inventory of raw materials?**	
	(1)	(2)	(3)	(4)
	Credit constrained		Credit constrained	
	No	Yes	No	Yes
Demand shock				
Change in sales (%) (10^{-2})	**0.02** (1.78)	**0.03** (3.36)	**0.04** (3.84)	**0.01** (1.82)
Change in sales x temporary (%) (10^{-2})	**-0.02** (1.67)	-0.01 (0.76)	**-0.02** (1.80)	0.00 (0.46)
Sector (omitted: (Other) manufacturing)				
Garments	-0.13 (0.13)	-0.21 (0.26)	-0.55 (0.48)	-0.66 (0.95)
Trade	-0.79 (0.91)	0.07 (0.07)	0.09 (0.09)	-0.36 (0.41)
Tourism	-0.22 (0.27)	0.31 (0.41)	0.87 (1.04)	0.04 (0.07)
Other	-0.62 (0.63)	0.36 (0.45)	0.27 (0.33)	-0.65 (0.84)
Size (omitted: Small)				
Medium	-0.48 (0.94)	-0.34 (0.84)	-0.64 (1.10)	0.83 (1.77)
Large	-0.32 (0.44)	-0.22 (0.33)	-0.32 (0.46)	0.06 (0.12)
Phnom Penh (dummy)	-0.50 (0.79)	-0.36 (0.55)	0.44 (0.58)	**1.69** (2.22)
Number of observations	96	144	95	143
Pseudo R^2	0.04	0.05	0.15	0.10

Note: standard errors are clustered at the firm level and t-values are reported in parentheses. Coefficients which are significant at 10% are reported in bold.

If the shock is temporary and the firm is not credit constrained, then this probability is reduced to only 2%. For firms that are credit constrained (column 4), we do not find a significant different response to permanent and temporary shocks.

Welfare costs of incomplete input smoothing due to credit constraints

In this analysis, we find that firms that are credit constrained are smoothing less than optimally. And the CRBS 2009 survey indicated that about half the firms expected the negative demand shock to be temporary, while 60% of these firms also reported that the availability and cost of finance had changed and that they had become more credit constrained.

What is the welfare cost of such incomplete input smoothing due to a credit constraint? This is a policy relevant question because improving access to finance may be a feasible policy option for economic policy-makers when firms are faced with a large negative demand shock.

In case the shock is temporary and the firm is credit constrained, then total costs are increased by $w(x_2^{T,cr} - x_2^T) + c[(\bar{x} - x_2^{T,cr})^2 - (\bar{x} - x_2^T)^2]$, where $x_2^{T,cr} \leq x_2^T$ is the choice of input by a firm that is credit constrained. The change in total cost (as a proportion of total adjustment costs for a non-credit constrained firm) can be written as

$$\frac{-w(\Delta x_2^{T,cr} - \Delta x_2^T) + c[(\Delta x_2^{T,cr})^2 - (\Delta x_2^T)^2]}{c(\Delta x_2^T)^2} \tag{6}$$

where $\Delta x_2^{T,cr} = \bar{x} - x_2^{T,cr}$ and $\Delta x_2^T = \bar{x} - x_2^T$. Note that $\Delta x_2^{T,cr} \geq \Delta x_2^T$ and therefore the expression shows that a firm which is credit constrained spends less on input costs but more on adjustment costs. If we assume that the non-credit constrained firm is smoothing inputs, and because $\frac{w}{c} = 2\Delta x_2^T$ (see equation 3), we can rewrite equation (6) also as

$$\frac{(\Delta x_2^{T,cr} - \Delta x_2^T)^2}{(\Delta x_2^T)^2}$$

This means that the welfare loss (as a proportion of total adjustment costs) due to incomplete smoothing is given by

$$\text{Welfare loss} = \frac{(change\ in\ input\ because\ of\ credit\ constraint)^2}{(change\ in\ input\ because\ of\ demand\ shock)^2}$$

In case the reduction in smoothing because of a credit constrained is small, the welfare loss is consequently small as well. On the other hand, if a credit constrained firm is forced to reduce its inputs strongly, the welfare loss will be much higher (because of the squared term in the numerator). Whether the actual welfare loss is therefore high or low is an empirical issue and needs to be estimated.

We can estimate the welfare cost of incomplete input smoothing for labor, but not for the capital stock and raw materials because we have no information on the percentage change of the use of inputs (only an ordinal variable indicating the direction of change). We can use the estimates from columns (3) and (4) in Table 5, implying that at a 30.7% temporary reduction in sales (the observed mean change) would imply a decline of permanent workers of -0.9% for firms that are not credit constrained, and a change of -6.9% for firms that are credit constrained.[22] Hence, the welfare loss due to the credit constraint is 44.4 times the total adjustment costs of firms that are not credit constrained.[23]

This estimate of the welfare cost of imperfect smoothing appears therefore relevant for policy makers, even though this estimate does not take into account other costs of imperfect input smoothing – such as unnecessary fluctuations in employment (which is costly for the workers and the state) and the higher risks of bankruptcy (as Table 2 showed that firms relying on informal finance were less likely to have gone bankrupt than firms relying on formal finance).

5. Discussion and conclusions

In this paper, we have analyzed risk coping behavior by firms in Cambodia following the global financial crisis using a panel survey that was implemented before the crisis (August 2007-March 2008) and during the crisis (July – November 2009). The survey shows that firms in Cambodia were hard hit by the economic crisis between 2008 and 2009, with an average fall in demand (sales) of 30% (Table 1). Firms

[22] (30 x (0.13-0.10)) = 0.9 (column 3) and (30 x (0.13+0.10)) = 6.9 (column 4).
[23] $(6.9-0.9)^2/(0.9)^2=44.4$.

adopted a myriad of responses, related to production, finance, labor and management. Credit-constrained firms were significantly more likely to have taken action and also there is some evidence that they were more likely to reduce hiring and increase firing, reduce the inventory of raw materials and reduce production capacity compared to the firms that were not classified as credit constrained (Table 4).

In our theoretical framework, we show that firms prefer to smooth their inputs in the presence of adjustment costs, especially if they expect a demand shock to be temporary. However, firms that are credit constrained will be adversely affected by the presence of liquidity constraints, and this will create a welfare loss due to incomplete risk coping.

Using the implications from this theoretical framework, we have estimated the responsiveness of labor, capital and raw materials input demand to demand shocks. The input demand of firms was strongly affected by the large negative demand shocks between 2008 and 2009. However, firms that were not credit constrained reduced their inputs much less than firms that were credit constrained when the demand shock was expected to be temporary. This suggests that credit constrained firms were less able to maintain their productive capacity, incurring higher adjustment costs in the future. We estimate that the welfare loss from incomplete smoothing due to credit constraints amounts to 44.4 times the adjustment costs of the firms that were not credit-constrained.

The first policy implication of these findings is to be aware of a 'contagion effect' across markets: the higher response of the labor market to the demand shock (by sub-optimal smoothing) reflects a constraint on the capital market. The policy implication is that the relevant policy lever to improve the labor market outcome is not a labor policy, but a financial policy (see for a similar finding and insight Bigsten *et al.* 2003).

The finding therefore emphasizes the role of financial sector development and regulations, and in particular the importance of the smoothing of credit supply itself. If in times of crisis lines of credit to firms are reduced, then reductions in investment as well as demand for labor and raw materials during crisis will be magnified. This is not an imaginary problem, as the range of discussions at the moment on the pro-cyclicality of various regulatory requirements (e.g. capital requirements) suggests that capital markets regulations can reinforce, rather than smooth, demand shocks (see for instance Repullo and Suarez, 2012) .

A second policy implication is the role of policies to absorb this sub-optimal smoothing. In Cambodia, for instance, this emphasizes the role of social safety nets. While the economy becomes increasingly open (and therefore vulnerable to global shocks) while moving away from subsistence agriculture to industry and services – the paper suggests that these emerging sectors won't be able to provide full smoothing for temporary shocks. Therefore additional safety nets will be needed to protect workers during economic crises.

Finally, our findings have implications for macroeconomic policies, through the role of expectations. Indeed insufficient smoothing can be self-fulfilling through a demand effect: if all firms perceive the shock to be permanent, they do a minimal amount of smoothing, which further depresses demand, making the shock indeed more permanent. In fact, a negative demand feedback loop might also arise from limited financial development or poorly regulated financial development (one or the other would increase the likelihood of firms being credit-constrained, which would constrain smoothing, hence depressing demand further). This emphasizes the role of credible policies (at least nationally, but possibly also through international coordination) to send a credible signal that the shock is temporary.

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