And Yet, They Last: The Employment and Productivity Effects of Crises on Firms in Portugal

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Abstract

This thesis examines the dynamic firm-level effects of the 2008 global financial crisis (GFC), the driving mechanisms of their persistence, and the linked labor (and factor) productivity dynamics. It proposes a simple dynamic macroeconomic model and uses administrative longitudinal matched employer-employee data for Portugal over 2004–17 to identify firm level, crisis-induced employment and productivity impacts and channels. Exploring the quasi-experimental variation in each firm's foreign demand resulting from the 2008 GFC, the thesis shows that while there was a significant effect on firm exits, there was also a strong effect on the diversification of external markets among continuing firms. These firms responded by adjusting the composition of their labor force towards more skilled labor, consistent with a lasting reduction in employment. Overall, this thesis finds evidence that the effects of the GFC were felt on revenues, employment, and productivity for half a decade after the shock hit, suggesting that transitory shocks entail "*scarring effects*" for firms (not just workers). Finally, the thesis documents that despite negative effects on individual labor (and factor) productivity, the GFC fostered the survival of the fittest with potential "*cleansing effects*" at the aggregate level.

Keywords: Great Recession, Business Cycles, Employment, Scarring Effects, Cleansing Effects, Firm Adjustment Margins, Productivity.

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Resumo

Esta tese examina os impactos dinâmicos da Grande Crise Financeira (GCF) nas empresas Portuguesas, examina os mecanismos subjacentes a efeitos persistentes e as respostas na produtividade. Propõe um modelo macroeconómico dinâmico e explora micro dados administrativos para Portugal entre 2004-17 para identificar, ao nível da empresa, efeitos e canais induzidos pela crise no emprego e na produtividade. Explorando uma quasi-experimental variação na procura externa de cada empresa causada pela GCF, esta tese mostra que ainda que tenham havido efeitos significativos na morte de empresas, também se observou uma diversificação de mercados externos pelas empresas sobreviventes. Estas empresas, encolheram a sua força de trabalho, ajustando-a privilegiando o trabalho mais qualificado. Em suma, os efeitos da GCF sentiram-se nas receitas, no emprego e na produtividade quase uma década volvido o choque, sugerindo que as crises cicatrizam as empresas (e não apenas os trabalhadores). Finalmente, esta tese mostra que apesar dos efeitos negativos na produtividade das empresas, a crise fomentou a sobrevivência de empresas mais produtivas, sugerindo que as crises podem ter efeitos 'purificadores' no agregado.

Palavras-chave: Grande Recessão, Ciclo Económico, Emprego, Efeitos de "cicatriz", Efeitos de "purificação", Margens de Ajuste, Produtividade.

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1. Introduction

How persistent are the effects of transitory shocks? That job displacements have tangible and long-lasting effects for individuals in terms of their earning levels, stock of human capital, and job prospects is a well-established fact in the literature on labor "*scarring*" (e.g. Jacobson, Lalonde, Sullivan 1993, Couch and Placzek 2010, Davis and Von Wachter 2011). However, how firms (and workers) adjust in response to crises and through which channels they do so remains a largely unexplored topic. Quantifying these impacts and channels matters considerably for collective prosperity. Exploring the causal impact of crises on firms sheds light on how – and how fast – economies adjust to negative shocks. The extent to which temporary shocks have persistent effects depends largely on firm adjustment dynamics. The (in)ability of firms to cope with temporary shocks can give rise to ripple effects, conditioning the economy's long-run trajectory. Should unproductive firms face higher chances of perishing, this inability can also translate into productivity-enhancing cleansing effects at the aggregate level.

This thesis contributes to the literature by theoretically and empirically identifying the impacts of an external demand contraction on Portuguese firms, the channels of adjustment driving the persistency of these effects, and the linked productivity dynamics. While most of the recent literature computes shocks at the regional level (Kovak 2013, Topalova 2010, or Yagan 2019) or industry level (Autor et al. 2014), this thesis does so at the firm level. In a quasi-experimental setting, the thesis explores a rich combination of longitudinal firm-level microdata, coupled with employer-employee administrative data and trade data, to estimate the lasting effects of global financial crisis (GFC)–induced external demand shocks on the trajectory of labor market outcomes, performance outcomes, probability of market exit, and several adjustment margins for Portuguese firms. Prior to the shock, Portuguese firms faced differentiated exposure to external demand shocks based on their baseline portfolio of export destination countries. The thesis exploits this ex-ante exposure and the reduced gross domestic product (GDP) growth in these destinations during the crisis, to approximate a GFC-idiosyncratic demand shock stemming from a contraction in exports toward these commercial partner countries. This identification strategy is consistent with international trade being an important channel in the propagation of crises among open economies. Rather than measuring the full effect of the crisis, which included the risk perception channel after the 2011 sudden stop, the thesis uses the (exogenous) GFC-induced, firm-level demand shocks to identify causal effects.

As a framework for the empirical work, the thesis develops a simple partial equilibrium dynamic macroeconomic model with heterogeneous firms. This model yields three main insights on how firms respond to an idiosyncratic demand shock. First, it clarifies the firm-level impacts of the shock illustrating how harder hit firms may face amplified market switching likelihood or how they risk shutting down altogether in response to a large enough external demand shock. Second, the model clarifies the adjustments in the level and composition of employment. Finally, it illustrates how highly productive firms are in principle less likely to perish, improving average idiosyncratic total factor productivity in the economy, with potential cleansing effects.

In line with these predictions, the empirical section has three parts. The first part focuses on the *direct impacts* of the GFC on firms. As a first direct impact, this thesis finds that harder hit firms were struck harder in terms of their revenues. Specifically, a one-percentage point higher GFC exposure translates into a differential contraction in sales of 3.8 percent in 2008. Strikingly, these revenue effects are highly persistent through time. The differentiated effects of GFC-induced firm-level demand shocks also affected the probability of market exit. Firms that were exposed to a one-percentage point higher 2008 GFC shock are found to be 1.8 percent more likely to shut down in 2009. Despite persistent effects on surviving firms' revenues, employment, and wage bill, the effect of the shock on firm exits was large but concentrated in one year (2009). In that year, firm closures explain almost entirely the employment decline registered, suggesting that firm exit played an important role during the crisis' initial adjustment period.

The last direct effect reported in this thesis relates to firms' ability to divert exports toward less strained commercial partners. This 'reallocation' can occur within the already existing export portfolio and/or involve channeling exports toward new trade partners. While the existence and magnitude of this effect greatly influence the degree of transmission of external cyclical downswings, there is still little empirical evidence on whether, and under which circumstances, such phenomenon indeed occurs. In theory, subdued demand from a given destination country hit by a idiosyncratic shock should translate into export reallocation[1] toward less intensely hit partner countries, even if the latter possibly entail accrued trade costs. However, if foreign countries are hit alike by a systemic shock, such diversion might not be profitable. In this process, perception is key: diversion becomes more alluring if agents perceive

[1] This thesis uses the terms "reallocation" and "trade diversion" interchangeably.

shocks as persistent, since discounted future inflows are likely to outweigh initial penetration costs. In this thesis, harder hit firms are shown to engage in trade diversion: a 10-percentage point higher GFC external demand 2008 shock is estimated to have led to one additional trade partner in 2009. This is a large effect given that over the 2004-2017 period the average exporting firm has 1.52 exporting partners.

The second part of the empirical analysis focuses on firms' *channels of adjustment* to the crisis. Faced with a sharp decline in demand, surviving firms can employ several coping strategies to stay afloat: reduce prices at the expense of profit margins, reduce costs, and/or adjust the input mix in production/technology. While the first two channels are in principle reversible, the third is more structural. Cost reduction strategies take several forms. Firms might reduce labor costs or other expenses, such as investment or materials. Within labor costs, firms might favor the intensive margin (fewer hours of work), the extensive margin (fewer workers), input prices (lower wages), or a combination of all these strategies. How prominent each of these adjustment channels is depends on the structural characteristics of the labor market (such as wage-setting mechanisms or labor market frictions) and product market (such as the degree of concentration).

This thesis shows that firms adjusted to the demand contraction through a wide array of channels. For surviving firms, a one-percentage point higher GFC exposure is found to translate into a differential contraction in employment of 1.6 percent in 2008. Similar results hold for hours worked. Naturally, these layoffs have collateral worker-level manifestations: workers initially working in one-percentage point harder hit firms find themselves 1.2 percent more likely to be unemployed in 2009 and 2010. As shown in this thesis, this entails persistent effects on their earnings and hours worked.

Next, the thesis turns to the question of whether relatively harder hit firms adjusted the composition of their labor force ("technological adjustment"). Understanding whether firms replace unskilled labor by skilled labor is key for understanding the speed of the economic recovery: it is difficult to undo structural changes of this nature, and thus they end up having lasting effects. However, the direction of the adjustment is not clear at first sight. Upfront, unskilled workers arguably have frailer job contracts. As such, on the one hand, it is possible that firms adjust via firing the easier matches to tie and untie (less skilled workers). Part of the more skilled workers' skills and tasks require costly job training, which increases the intertemporal opportunity cost of laying them off. Firms may also be induced to lay off fewer

specific workers, avoiding losing those that are set to become specific through investments (not because of past investment itself (as it is sunk) but because this type of worker may be absent from the market later on). On the other hand, when faced with severe liquidity constraints, firms may be forced to adjust via laying off expensive skilled workers and/or hiring cheap unskilled workers. On this score, this thesis finds that when faced with a severe shock, firms adjust by altering the composition of their labor force toward a more skill abundant mix. These results echo the predictions of Caballero and Hammour (1994) who suggest that in periods of low creation and high destruction of jobs, there may be good reasons to think that the best matches will be safeguarded. Aside from adjustments in technology, this thesis also investigates whether harder hit firms invest less and spend less on materials than their mildly hit counterparts do. Both these margins are shown to be relevant for firms. Finally, this thesis follows the growth decomposition of Gopinath and Neiman (2014) to study the macro-level trade margins of adjustment, investigating the mechanism of adjustment to declining exports and showing that firms adjusted mainly through the intensive margin (reduced exports by incumbents) while the extensive margin (entry and exiting of firms) played only a marginal role.

Lastly, the aftermath *productivity effects* of the crisis are addressed. The thesis evaluates the crisis-induced individual productivity effects and discusses potential aggregate effects brought about by the crisis. The question of whether recessions foster the survival of the fittest firms at the expense of the weakest, while at the same time promoting productive reallocation of resources, is a well-established hypothesis that has intrigued economists ever since Schumpeter coined the term "creative destruction" (see Davis and Haltiwanger (1992), or Mortensen and Pissarides (1994)). According to this view, firms that are more productive would have relatively higher chances of survival under periods of economic stress. The alternative narrative, put forth by Caballero and Hammour (1994), holds that crises might have an "insulation" effect instead: since crises stunt firm births, unproductive firms are artificially shielded against competition. Yet, empirical evidence on whether cleansing effects indeed occur remains mixed. Griliches and Regev (1995) for example, find only mild empirical evidence for this theory, while Barlevy (2002) sides with Caballero and Hammour (1994), suggesting that crises have sullying effects. Determining which of these views holds in reality is critical to determine whether recessions might have an unseen benefit. This thesis argues that although harder hit firms were struck harder in terms of productivity, the crisis may nonetheless have entailed cleansing effects on the aggregate economy. In particular, it finds that larger, more productive firms, or firms with a higher share of skilled workers, are less likely to exit the market relative to their similarly

shocked counterparts. The cleansing effect documented here is mainly a *composition* (or *selection*) effect holding at the aggregate level. As such, it does not contradict the observed individual-level scarring effects, which consist of surviving harder hit firms being struck harder (and persistently) in revenues, employment, and factor productivity relative to their mildly hit counterparts. Granted, these individual-level effects for hard hit firms may also influence aggregate productivity. However, which of these two opposing forces dominates at the aggregate level is outside the scope of this thesis. The present manuscript simply documents their co-existence.

Taken together, these findings bear important policy implications. Firm-level adjustments, and the productivity effects discussed in this thesis, matter for policy design and for the effective targeting of resources in response to shocks. For one thing, decision makers should account for the interplay between worker- and firm-level policies, as firm-level policies may trickle down to workers through job security and stable earnings. For another, government policy should acknowledge the trade-off between short-term welfare deterioration stemming from job destructions and productivity-enhancing cleansing effects. Supporting businesses at the brink of collapse may soften the former, but may curtail the latter along the way.

This research relates to several strands of the literature. First, it tracks a growing literature on the effects of trade shocks using large panel administrative data sets such as Dix-Carneiro and Kovak (2018), Autor et al. (2014), Menezes-Filho and Muendler (2011), Dauth et al. (2017), or Utar (2014). Specifically, it sides closely with Fernandes and Silva (2020), who assess the impact of changes in external demand on firms' performance and labor market outcomes in Brazil and Ecuador. The authors find differences in terms of wages and months worked in adjustment to shocks, with workers initially working in harder hit firms being relatively more affected. For harder hit firms, they find lower total employment together with lower total wages. Yagan (2019), leveraging the variability in regional unemployment rates, shows that agents living in harder hit regions (higher regional unemployment) are more hurt than their otherwise similar counterparts living in mildly hit regions. However, Yagan (2019) is silent on firm-level effects, while the bulk of Fernandes and Silva's (2020) analysis is also related to the worker level. The present work differs from most of the cited literature not only in its focus on firms, but also in computing the shock at the firm level. To assess the firm-level adjustments to a shock, computing such shock at the firm level is more appropriate than doing so at the regional or industry level.

Furthermore, no one has undertaken such a task for Portugal – a middle-income European country where adjustment mechanisms might differ from previously studied countries and where the labor market is tightly regulated (and with lower levels of market informality), possibly favoring different adjustment margins for firms. Moreover, this thesis also differs from most of the literature in that it focuses on the persistent effects of transitory shocks, while most of the trade literature focuses on permanent shocks, such as trade liberalization or the decline in trade uncertainty (see Dix-Carneiro and Kovak (2018) and Schott and Pierce (2016)). The findings reported in this thesis suggest that transitory, macro-level shocks generate micro-level transformation with long-lasting effects, thus implying that crises may have scarring effects not only for workers, but also for firms. Additionally, the results reported here complement the scarce existing literature looking at the worker-level medium-term impacts of crises (see Fernandes and Silva 2020). While the majority of the literature hovers around the short- and long-run effects of crises, studying this "missing middle" remains fertile ground for academic research. Finally, the model proposed here proves to be important in explaining the interplay between the impacts, channels, and productivity effects of transitory demand shocks.

The remaining of the thesis is organized as follows. Section 2 lays down a simple dynamic macroeconomic model. Section 3 describes the main data sets used, sampling procedures and descriptive statistics. Section 4 describes in detail the methodology and construction of the main outcome variables. Section 5 presents the results on the impacts, channels, and productivity effects of the crisis. Section 6 presents robustness checks, and Section 7 concludes.

2. A Simple Macroeconomic Model

This section proposes a simple dynamic partial equilibrium model, with heterogeneous firms, laid down as a framework for the empirical analysis. It offers baseline illustrations on the impact of an external demand shock on firms, in terms of sales, exits, and market switching patterns. The model is also informative on the ensuing labor and technological channels of adjustment to the shock. Concretely, the model offers predictions on: (*i*) the direction and magnitude of the employment and wage bill changes, and (*ii*) the direction of the change in the ratio of skilled to unskilled labor. Finally, the model predicts cleansing effects to occur in the economy via the relatively higher chances of survival of more efficient firms. Appendix III presents more detail on some pivotal algebraic steps discussed throughout this section.

Environment and Technology There is a unitary continuum of firms operating in three markets: labor, good, and credit markets. Each firm's j technology is given by decreasing returns to scale function:

$$Y_{jt} \equiv F\left(L_{jt}^{u}, \overline{L_{jt}^{s}}\right) = A_{jt} {L^{u}}_{jt}^{1-\alpha} \overline{L_{jt}^{s}}^{\beta} \text{ with } \alpha, \beta \in (0;1) \text{ and } 1-\alpha+\beta < 1$$

where L_{jt}^{u} stands for unskilled labor inputs, and $\overline{L_{jt}^{s}}$ are skilled and specific labor inputs, assumed to be fixed in the short run for each firm. Fixing skilled labor is admittedly a simplifying assumption. However, it can be rationalized in light of matching and searching difficulties, expensive training, and re-hiring costs if displacement ever takes place. Idiosyncratic total factor productivity, A_{jt}, is introduced à la Hicks. Firms are price takers in the inputs market and thus take unskilled wages $w_{jt}^{u} = w_t$ as given. All firms face the same nominal unskilled wage rate. Firms take the output price p_{jt} as given. Firms are subject to idiosyncratic demand shocks on this price, as discussed below. Each period has two stages.

Stage I: The problem of the firm in stage one is to maximize Π_{jt} by choosing over its flexible factor input

$$\underset{L_{jt}^{u}}{\text{Max}}\, \Pi_{jt} = p_{jt} A_{jt} {L^{u}}_{jt}^{1-\alpha} \overline{L_{jt}^{s}}^{\beta} - w_t L_{jt}^{u} - \phi_{jt} - [r_{jt-1} + (1-\gamma_t(A_{jt}))\theta] b_{jt-1} \quad \forall_{t,j}$$

where $A_{jt} = A_{jt}(\underbrace{i_{jt-1}}_{+})$ so that productive investments i_{jt-1} done at the end of period $t-1$ have effects on total factor productivity (TFP) at the beginning of t. How this investment decision takes place is discussed below. The firm's stock of debt in stage one of period t, denoted b_{jt-1}, is determined at the end of period $t-1$.[2] ϕ_{jt} is a fixed cost of operation, which pays for the intangible or tangible assets necessary for production, including the remuneration of skilled workers. The interest rate r_{t-1} is determined in stage two of period $t-1$, applied to the stock of debt determined in that same stage. There is an installment θb_{jt-1} due at the end of the current period to pay for a share θ of the stock b_{jt-1} where $\theta \in (0;1)$. θ is an exogenous parameter in our model and can also be thought of as the share of maturing debt. There is a debt moratorium $\gamma_t(A_{jt})\theta b_{jt-1}$ provided by the banking sector, where $\gamma_t(A_{jt}) \in (0;1)$ such that more productive firms can benefit from a higher debt moratorium, given their lower risk of default. In Portugal, prior to the shock, banks were giving poorly performing firms the possibility of extending their debts (through maturity changes). After a long period of zombie

[2] One can justify the initial contraction of debt with a market entry cost.

firms, the shock and the financial crisis that followed led to a more restrictive policy by banks and this perquisite became dependent on a risk evaluation. The introduction of the term $\gamma_t(A_{jt})$ captures this institutional context. Taking first-order conditions, firms set the marginal product of labor equal to the firm-specific real wage rate. Solving for the optimal labor:

$$L^{u*}_{jt} = \left(\frac{p_{jt}\overline{L^s_{jt}}^{\beta}(1-\alpha)A_{jt}}{w_t}\right)^{1/\alpha} \text{ and } L^{s*}_{jt} = \overline{L^s_{jt}}$$

Firms in this simple economy have, however, outside market options to which they can allocate a share $\rho(d_m) \in (0,1)$ of their production. By paying a one-shot market entry fixed cost $k(d_m)$ firms can divert $\rho(d_m)Y_{jt}$ and sell at price σ_{mt} instead of price p_{jt} to *one* external market among a set of available markets $m = \{1,2,\dots,N\}$. The distance between the firm and the destination market is denoted by d_m. Consistent with the gravity equation of trade

$$\frac{\partial\rho(d_m)}{\partial d_m} < 0 \text{ and } \frac{\partial k(d_m)}{\partial d_m} > 0$$

In this model

$$Cov(\sigma_{mt}, p_{jt}) = 0, \forall m, t$$

If firms decide to divert to market *m*, their profits are given by

$$\Pi^m_{jt} = (1-\rho)p_{jt}A_{jt}L^{u}_{jt}{}^{1-\alpha}\overline{L^s_{jt}}^{\beta} + \rho\sigma_{mt}A_{jt}L^{u}_{jt}{}^{1-\alpha}\overline{L^s_{jt}}^{\beta} - w_tL^u_{jt} - \phi_{jt} - k_m - [r_{jt-1} + (1-\gamma_t(A_{jt}))\theta]b_{jt-1}$$

Stage II: At the end of the period (stage two), borrower firms meet with lenders and default d_{jt} or survive into the next period according to the exogenously defined rule

$$d_{jt} = \mathbb{1}(p_{jt}A_{jt}L^{u*}_{jt}{}^{1-\alpha}\overline{L^s_{jt}}^{\beta} + \eta - w_tL^{u*}_{jt} - \phi_{jt} < [r_{jt-1} + (1-\gamma_t(A_{jt}))\theta]b_{jt-1})$$

If firms default, they perish forever; otherwise, they choose how much i_{jt} will be added to b_{jt-1} to form b_{jt}, the stock of debt holding at the beginning of period $t+1$. The underlying assumption is that investment is financed exclusively through debt. Firms also pay $[r_{t-1}+(1-\gamma_t(A_{jt}))\theta]b_{jt-1}$ at this stage. The law of motion for debt is given by

$$b_{jt} = \begin{cases} (1-\theta)b_{jt-1} + i_{jt} \text{ if } \Pi_{jt} > 0 \\ (1-\theta)b_{jt-1} + i_{jt} - \Pi_{jt} \text{ if } \Pi_{jt} \in (-\eta; 0) \text{ where } \eta > 0 \\ 0 \text{ if } \Pi_{jt} < -\eta \end{cases}$$

where $-\eta$ is the exogenous threshold value below which negative temporary profits can no longer be financed with debt. If $\Pi_{jt} \in (-\eta; 0)$, negative profits can be financed through debt. If

profits are too low (below $-\eta$), the firm defaults, and debt is cleared. Firms choose i_{jt} implicitly solving

$$\frac{\partial \mathbb{E}[\Pi_{jt+1}]}{\partial i_{jt}} = 0$$

Finally, a no-Ponzi-game condition is imposed to prevent explosive paths for debt:

$$\lim_{T\to\infty} \frac{b_{jT+1}}{\prod_{s=t}^{T}(1+r_{js})} \leq 0$$

Idiosyncratic Demand Shock and Comparative Statics This thesis closely follows Kozeniauskas et al. (2020) and models an idiosyncratic demand shock via the price of output. No shock is taking place in A_{jt}[3]. For two different firms j and i, it evaluates the effects of a mild demand shock in j versus a hard demand shock in i such that

$$|\frac{\Delta p_{jt}}{p_{jt}}| < |\frac{\Delta p_{it}}{p_{it}}| \text{ for } i \neq j$$

The elasticities of optimal labor with respect to output prices, of revenues (at the optimum for labor) with respect to prices, and of the wage bill (at the optimum for labor) with respect to prices are given by

$$\epsilon_{L^{u^*}_{jt};p_{jt}} = \epsilon_{wL^{u^*}_{jt};p_{jt}} = \epsilon_{R^*_{jt};p_{jt}} = \frac{1}{\alpha}$$

This means that a 1 percent decrease in output prices leads to a decrease of $\frac{1}{\alpha}$ percent in unskilled employment, revenues, and the unskilled wage bill, for any given firm in the economy, regardless of TFP. Furthermore, since $\alpha \in (0;1)$, this elasticity will be greater than one. It follows that, with skilled labor held fixed in the short run, a 1 percent decrease in output prices leads to an increase of $\frac{1}{\alpha}$ percent in the ratio of skilled to unskilled workers. Whether or not firms hit harder by the shock adjust relatively more intensely can be determined by simply noticing that

$$\epsilon_{L^{u^*}_{jt};p_{jt}} = \frac{\Delta L^{u^*}_{jt}/L^{u^*}_{jt}}{\Delta p_{jt}/p_{jt}} = \frac{1}{\alpha} \Leftrightarrow \frac{\Delta L^{u^*}_{jt}}{L^{u^*}_{jt}} = \frac{1}{\alpha}\frac{\Delta p_{jt}}{p_{jt}}$$

[3] Since changes in A_{jt} could in principle be driving opposite direction changes in p_{jt}, it is important to determine whether they are offsetting each other such that $p_{jt}A_{jt}$ stays constant. The change in p_{jt} is assumed to stem *directly* from the demand side, so that the shock is fully transmitted.

This means that a $\frac{\Delta p_{jt}}{p_{jt}} \times 100$ percent decrease in output prices leads to a decrease of $\frac{1}{\alpha}\frac{\Delta p_{jt}}{p_{jt}} \times 100$ percent in unskilled employment, revenues, and the unskilled wage bill. Thus, harder hit firms will have larger percentage changes in employment, revenues, and wage bill.

The expressions for elasticities derived so far hold at the individual firm level. That is, they hold for an idiosyncratic and unique shock. When the shock takes place at the aggregate level in the sense that every firm suffers the same type of shock but with different magnitudes, then the general equilibrium bites and the wage rate will no longer be constant. However, this thesis compares shocked firms across themselves, not the aggregate. The shock can be thought of as striking only a subset of firms in this economy. If only exporting firms are hit, it is possible that the domestic unskilled labor market equilibrium wage remains unchanged. In the limit, the results would even hold in a more general subset so long as the wage change is the same for all firms. If so, regardless of whether the new wage rate is being driven by p_{jt} or the whole set of price changes, these results still apply when comparing different firms.

Market reallocation If they decide to reallocate production, firms will always prefer the destination yielding highest profits. Denote such market m^* and the corresponding profits:

$$\pi_{jt}^{m^*} = Max\{\pi_{jt}^1, \pi_{jt}^2, \dots, \pi_{jt}^N\}$$

Firms will reallocate if:

$$\pi_{jt}^{m^*} > \pi_{jt} \Leftrightarrow \rho(d_{m^*})\sigma_{m^*t}A_{jt}{L^{u^*}}_{jt}^{1-\alpha}\overline{L_{jt}^s}^{\beta} - k(d_{m^*}) \geq \rho(d_{m^*})p_{jt}A_{jt}{L^{u^*}}_{jt}^{1-\alpha}\overline{L_{jt}^s}^{\beta}$$

At the optimum for unskilled labor

$$p_{jt}^{\frac{1}{\alpha}}\left(\frac{\sigma_{m^*t}}{p_{jt}} - 1\right) \geq \frac{k(d_{m^*})}{\rho(d_{m^*})f\left(A_{jt}, w_t, L_{jt}^s\right)}$$

In absence of penetration costs, $k(d_{m^*}) = 0$, reallocation is determined entirely by relative prices. Also, reallocation is less likely the further away the most profitable destination is. Determining under which condition the left-hand side varies negatively with price simultaneously determines under which circumstances reallocation is more likely to take place in response to a demand shock

$$\frac{\partial[p_{jt}^{\frac{1}{\alpha}-1}\sigma_{m^*t} - p_{jt}^{\frac{1}{\alpha}}]}{\partial p_{jt}} = \frac{1-\alpha}{\alpha}\sigma_{m^*t}p_{jt}^{\frac{1}{\alpha}-2} - \frac{1}{\alpha}p_{jt}^{\frac{1}{\alpha}-1}$$

$$\frac{\partial[p_{jt}^{\frac{1}{\alpha}-1}\sigma_{m^*t}-p_{jt}^{\frac{1}{\alpha}}]}{\partial p_{jt}}<0\Leftrightarrow(1-\alpha)\sigma_{m^*t}<p_{jt}$$

If this holds, reallocation is more likely to occur in response to an idiosyncratic demand shock.

Shutdown Condition At the end of the period, firms default if

$$p_{jt}A_{jt}{L^{u^*}}_{jt}^{1-\alpha}\overline{L_{jt}^{s}}^{\beta}+\eta<\left(r_{t-1}+(1-\gamma_t(A_{jt}))\theta\right)b_{jt-1}+w_t{L^{u^*}}_{jt}+\phi_{jt}$$

At the optimal amount of labor, this becomes

$$p_{jt}<\left(\frac{w_t}{1-\alpha}\right)\left(\frac{1-\alpha}{w_t\alpha}\right)^{\alpha}\frac{\left((r_{jt-1}+(1-\gamma_t(A_{jt}))\theta)b_{jt-1}+\phi_{jt}-\eta\right)^{\alpha}}{A_{jt}\,\overline{L_{jt}^{s}}^{\beta}}=p_{jt}^{T}$$

This expression pins down the threshold value for p_{jt}^{T} below which firms close. For an initial $p_{jt}>p_{jt}^{T}$, there exists a large enough $\frac{\Delta p_{jt}}{p_{jt}}=\frac{p'_{jt}}{p_{jt}}-1<0$ capable of turning $p'_{jt}<p_{jt}^{T}$. Assuming that firms have initially similar values for p_{jt}, A_{jt}, b_{jt-1}, and r_{jt-1}, this implies that harder hit firms have in principle a higher probability of exiting the market. It also follows that for firms having suffered a similar idiosyncratic shock, and that are equal in everything except idiosyncratic TFP, firms with higher TFP are relatively less likely to perish (not only due to higher revenues, but also due to a higher debt moratorium).

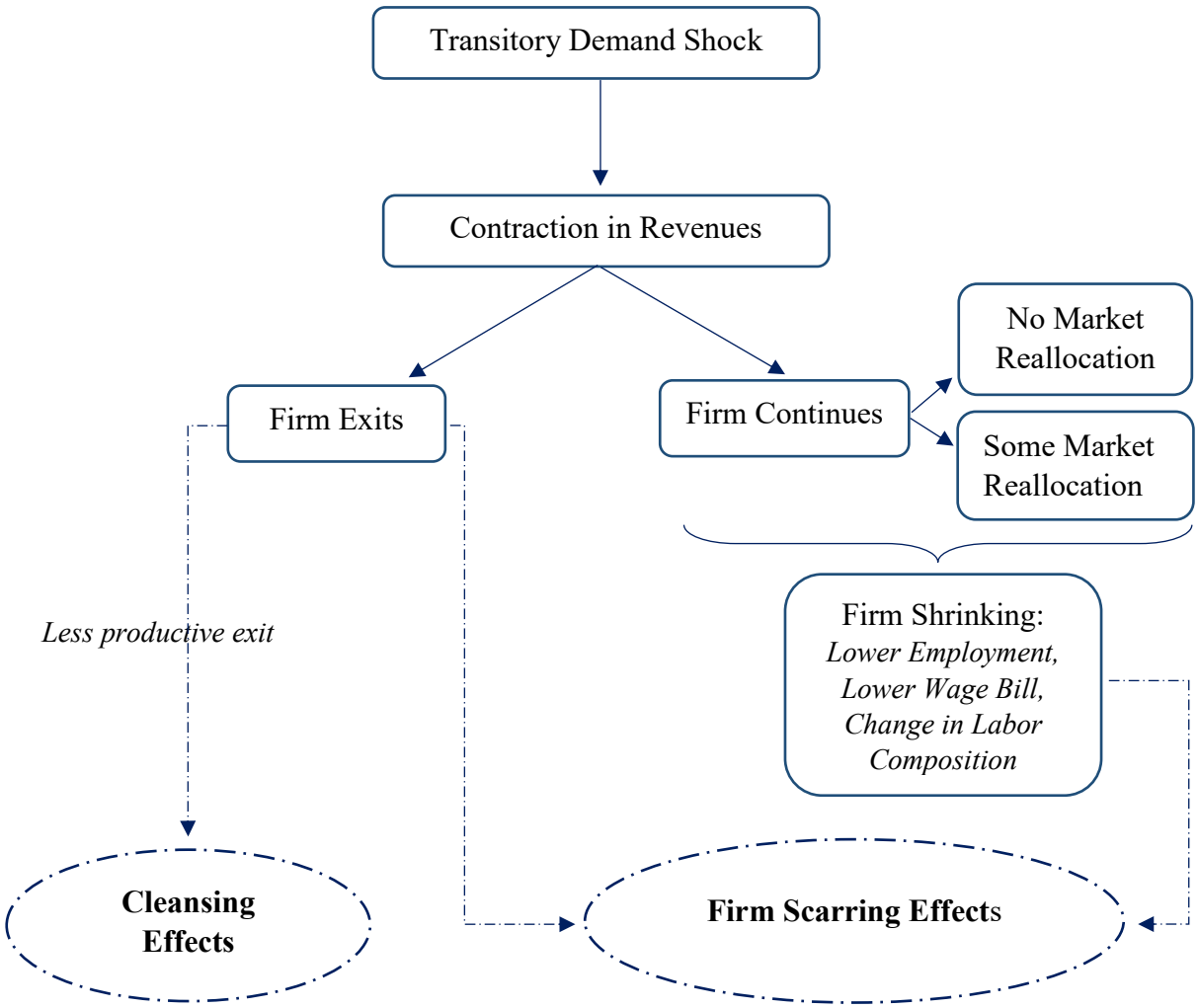
The core predictions of the model are wrapped up around three comprehensive propositions, schematically presented in Diagram 1.

Proposition I: *In presence of an idiosyncratic demand shock, harder hit firms face a higher decline in revenues, a higher likelihood of perishing, and a higher likelihood of reallocating production to their outside option, relative to mildly hit firms.*

Proposition II: *In presence of an idiosyncratic demand shock, harder hit (surviving) firms are expected to: (i) adjust the composition of their labor toward a more skill abundant mix, with such adjustment stemming essentially from a reduction in unskilled labor, and (ii) reduce employment and the wage bill.*

Proposition III: *For a similar idiosyncratic demand shock, firms with higher idiosyncratic TFP face relatively higher chances of survival. Thus, the model predicts that cleansing effects can occur in the aftermath of a shock via higher average idiosyncratic TFP.*

Diagram 1: The effects of a transitory demand shock on firms



3. Data, Sampling, and Descriptive Statistics

This thesis relies on the following data sets.

Quadros de Pessoal (QP) The Portuguese Ministry of Employment, Solidarity and Social Security collects administrative yearly matched employer-employee micro-level data that covers the universe of all workers and firms employing at least one dependent employee, from the Portuguese private sector. The dataset is supplied by Statistics Portugal *(Instituto Nacional de Estatística de Portugal, INE)* and DGEEC (*Direção-Geral de Estatísticas da Educação e Ciência*). By law, each employer with at least one dependent employee must report demographic and job-related information on his/her employees. This information includes age,

weekly hours worked (regular and extra hours), nominal earnings (base labor earnings for normal hours worked, as well as regular payments and premiums), educational attainment, gender, type of contract, ID from employing firm. Employers must also deliver information to the competent authority on the firm's industry, region, sales, number of employees. By means of unique identifiers for firms and workers, these units can be followed over time (longitudinal data). However, this panel does not feature any data for independent workers or public servants. This data set includes around three million workers and 200,000 firms per year. Due to its compulsory nature, the collected data yields a longitudinal firm-level panel shielded against frequent caveats (such as panel attrition). Furthermore, since the employer is the one actually reporting the data, some variables are less prone to measurement errors (like self-reported qualification). Taken together, these elements act to bolster confidence in the soundness of the data.

Sistema de Contas Integradas das Empresas (SCIE) This dataset, collected by Statistics Portugal and the DGEEC (*Direção-Geral de Estatísticas da Educação e Ciência*), provides fiscal and accounting data for all companies producing goods and services in Portugal, including independent workers, on a yearly basis. However, the dataset does not include financial and insurance firms, nonprofit organizations, or public administration units. As such, all of the above are excluded from the overall analysis. The dataset includes a vast array of variables, such as labor costs, after-tax profits, gross value added, and number of workers, all of which are extensively used in this thesis. This dataset can be linked to *Quadros de Pessoal* by means of the key unique anonymized firm identification variable "NPC_FIC." Firms with only one worker are dropped from this dataset.

Comércio Internacional (CI) Firm-level monthly data on exports and imports are available via this dataset, which is collected by Statistics Portugal and the DGEEC (*Direção-Geral de Estatísticas da Educação e Ciência*). This data can be used to identify the destination country of each firm's exports and the country of origin of their imports. It covers all firms subject to value-added taxation that have engaged in intracommunity transactions whose total value exceeds a given threshold amount annually. This dataset can be merged with *Quadros de Pessoal* and SCIE by means of the aforementioned unique firm identification variable.

World Development Indicators Yearly data from World Bank's WDI is gathered to get real growth rates of Portuguese firm's trade partner countries. Real growth rates are computed as the yearly percentage "[…] *growth rate of GDP at market prices based on constant local*

currency. Aggregates are based on constant 2010 U.S. dollars […]."[4] To combine this data with the main dataset one first has to create a crosswalk between country names in WDI and those in trade data. Both datasets are then merged using as unique identification each year-country observation in World Bank data.

OECD Data To convert nominal variables (such as wage bill, average wages, revenues, and so forth) into real variables, data from the OECD relative to Portuguese inflation, as measured by the yearly consumer price index (CPI), was extracted. The base year of the index is 2005 ($CPI_{2015} = 100$). To adjust nominal variables for inflation in a given year, the index is divided by 100 and the variables in question are divided by the result of that former division.

Sampling and Data Cleaning Procedures: The analysis follows firms from 2004 to 2017. Due to poor data quality, agriculture, mining, and fishing are discarded from the outset. For the firm-level analysis, the sample is confined to firms shocked in 2008. This means that firms that only existed in the panel prior to 2008 are excluded from the onset. Likewise, firms that only show up in the panel after 2008 are discarded. Firms that only existed in 2008 are also excluded, together with firms that showed up before 2008, after 2008, but not in 2008. For the former, it is not possible to follow the evolution of their relevant outcome variables through time. For the latter, there is no shock measure for them. Finally, firms are required to be present in the panel at least two years prior to the shock. This condition is imposed to ensure the existence of pre-trends for the firms. All merged firms in QP, SCIE, and CI meeting the listed criteria, for which there is a non-missing shock value, thus populate the main sample.

To determine firms' broad geographical regions, the setup relies on the Nomenclature of Territorial Units for Statistics at the regional level (NUTS 2). According to this classification, firms can be located in Lisbon, in the North, in Alentejo, in the Center region, in Algarve, in Madeira, or in the Azores. A broader nomenclature exists, NUTS 1, but its level of detail is coarser. To determine the firms' sector of activity throughout the years, a crosswalk was needed to adjust the classification in place prior and posterior to 2007. This was necessary since prior to 2007 activities were classified according to the Classificação das Atividades Económicas Rev 2.1 (CAE Rev 2.1), but from 2007 onward, Portuguese activities have been revised to track international classifications and the new classification in place since then is the Classificação das Atividades Económicas Rev 3 (CAE Rev 3). This harmonization crosswalk was built from the underlying two-digit CAE sectors and yielded 31 large categories, later reduced to 29

[4] World Bank national accounts data.

categories, once agriculture and fishing were discarded. Finally, to determine the level of educational attainment of individuals, the thesis focuses on a one-digit classification of highest educational attainment. The education labels were adjusted slightly for 2004 and 2005 to ensure a full harmonization of categories across time. A worker is deemed skilled if he or she has any form of superior post-high-school education. In addition, before collapsing workers into firms, whenever a worker appears twice within the same year in the panel with several jobs, his or her highest paying one was selected (mostly likely, his or her primary job). Lastly, observations such as those featuring negative values for production were discarded, as they were likely due to misreporting (together with those having missing (or unmatchable) firm unique identifiers).

Descriptive Statistics: Table 1 reports some descriptive statistics for the main outcome variables for the pre-shock period (2004–07) and for the post-shock period (2008–17). Given the way in which the sample was selected, the same number of firms was expected in the pre- and post-shock periods. On average, Portuguese firms in the sample were more exposed to low external demand in 2008–17 compared with 2004–07. This should not come as a surprise, considering that the main commercial partners of Portuguese firms are European countries and a severe stalling of economic activity took place after the GFC in the euro area. Firms in the sample had an average value for the log of total employment of 2.8 in 2004–07 period and a value of 3.0 in 2008–17. For the log of the total wage bill, firms had on average a value of 9.6 in 2004–07 and 9.9 in 2008–17. Average log revenues and average firm productivity were similar in both time spans. The fact that firm closures were more frequent during 2008–17 compared with 2004–07 is *partly* justified by the sample construction. By confining the sample to shocked firms, the number of firm exits is attenuated in 2004–07. However, by excluding entering firms in the post 2008 period, this thesis also attenuates exits post-2008 as these entering firms could close before 2017. Finally, most firms were importing in the 2007 baseline year.

Table 1: Summary Statistics

	2004-2007		2008-2017	
	Mean	Std. Dev.	Mean	Std. Dev.
Firm outcomes				
Total employment (log)	2.8	1.3	3.0	1.3
Total hours within firm (log)	7.6	1.4	7.8	1.4
Av. wage per worker (log)	6.7	0.5	6.9	0.5
Net profits (log)	8.5	4.5	8.4	4.9
Average productivity of labor (log)	10.2	0.7	10.2	0.7
Total revenues per capita (log)	11.6	0.9	11.7	0.9
Total revenues (log)	14.6	1.5	14.7	1.6
Total wage bill (log)	9.6	1.5	9.9	1.5
Firm Exits	4.4%	20.5%	9.9%	29.9%
Firm-level shock				
Av. Shock (in %)	-1.8	3.5	-1.1	2.4
2008 Shock Interquartile Range		0.89		
2008 Shock 90-10 Gap		7.28		
2008 Shock 99-1 Gap		11.16		
Controls (pre-shock period)				
Importer dummy	84%	36%		
Av. growth in employment by firm	7%	61%		
Av. growth in total wages	14%	78%		
Av. growth in av. wages by firm	7%	43%		
Total number of firm-year obs.	63293		120195	
Total number of unique firms	18262		18262	

Note: Relevant firm statistics based on sample containing shocked firms in 2008 and excluding firms from agricultural and related sectors. All monetary values are expressed in real terms. Data Source: *Quadros de Pessoal*, *Comércio Internacional*, *SCIE*, *WBI* and *OECD.*The shock measure was computed using the negative of a weighted average of the growth rates in firm partner countries' GDP. Since negative net profits are in principle possible, zero replaced the log of net profits in case net profits were negative. Firm exit stands for a dummy for whether the firm abandoned the panel in a given year. This variable equals 1 only in case the firm left the market in a given year *t and* was operating in year *t-1*. To compute this variable, the otherwise unbalanced panel was balanced. Importer dummy stands for a variable for whether or not a given firm was importing at baseline year. The gaps presented are the percentage point difference between the value for the firm at the 25th and 75th 2008 shock percentile, for the 10th and 90th percentile, and for the 1st and 99th percentile.

4. Identification and Empirical Strategy

Shock and Identification: Using firm data, customs data, and GDP growth data for trade partners, a measure of exposure of each firm to an external GFC demand shock is built. This variable for firm j in year t is the $shock_{jt}$. This idiosyncratic demand shock constitutes an exogenous source of variation with the potential to isolate the causal micro-level effects of the

GFC on firm outcomes. It is a weighted average of trade partner countries' growth rates. Formally, such weights are computed as

$$w_{jt_o}^{d} = \frac{X_{jt_o}^{d}}{\sum_{d=1} X^{d}{}_{jt_o}} \text{ with } w_{jt_o}^{d} \in [0;1] \text{ and } \sum_{d=1}^{D} w_{jt_o}^{d} = 1$$

where $X_{jt_o}^{d}$ represents a given Portuguese firm *j*'s exports toward country *d* in year t_o, and $\sum_{d=1} X^{d}{}_{jt_o}$ represents the sum of firm *j*'s exports in year t_o. Since data on exports in *Comércio International* is in monthly frequency, to compute $X_{jt_o}^{d}$, the trade data was collapsed using the fact that $X_{jt_o}^{d} = \sum_{m=1}^{12} X_{jt_o m}^{d}$, where *m* stands for months. Similarly, to compute total exports for Portuguese firm *j* in a given year t_o the fact that $\sum_{d=1} X^{d}{}_{jt_o} = \sum_{d=1}^{D} \sum_{m=1}^{12} X_{jt_o m}^{d}$ was used. The following expression is used to compute the shock for each firm *j* in $t_o + 1$:

$$shock_{jt_o+1} = -\sum_{d} w_{jt_o}^{d} \times g_{t_o+1}^{d}$$

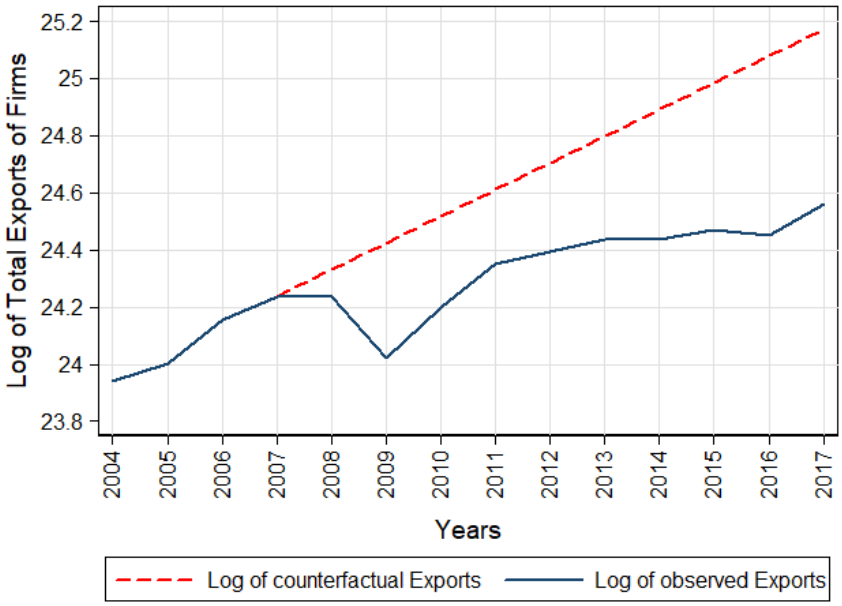
where $g_{t_o}^{d}$ stands for the growth rate of partner country *d* in year $t_o + 1$. This essentially models the shock as a weighted external demand shock coming from the rest of the world. The weights $w_{jt_o}^{d}$ are used in year t_o, to avoid "endogenizing" them: by using year t_o weights for the shock in year $t_o + 1$, the weights are shielded against endogenous reactions to the shock. If year $t_o + 1$ weights were employed instead, it could be argued that the dynamics of the shock acted to change the weights and so the measure would no longer constitute an exogenous source of variation. Furthermore, when computing this measure, if a given firm is importing in a given year t_o, but not exporting, it gets assigned a shock value of zero percent in year $t_o + 1$, since it cannot be said that such firm is (directly) subject to an external demand contraction. Then, this summation is multiplied by -1 for graphical readability purposes: a one-percentage point change in the shock measure,

$$\Delta shock_{jt_o+1} = 1 > 0 \Leftrightarrow \Delta \sum_{d} w_{jt_o}^{d} \times g_{t_o+1}^{d} = -1 < 0$$

corresponds to an increase in the GFC-induced external demand contraction faced by firms. If the minus sign were not there, an increase in the variable $shock_{jt_o+1}$ would correspond to a decrease in the GFC-induced external demand contraction. The shock is computed for 2008 to capture the immediate impact of the GFC trade shock. Computing the shock at a later stage would potentially compromise the estimates by capturing posterior recovery effects. To corroborate the choice of $t_o + 1 = 2008$ as the year in which the shock is computed, Figure 1

evaluates what would have happened to the log of total exports for the sampled firms had the growth rate of total exports remained constant at its pre-2008 geometric mean. This trend is then confronted with the observed behavior of the log of total exports as time progressed. This exercise shows a strong and negative level effect brought about by the 2008 contraction of firm exports.

Figure 1: Evolution of Log of Firms' Total Exports, against Counterfactual Evolution of Log of Total Exports



Note: This figure displays the yearly evolution of the log of total exports of shocked firms in the sample (excluding firms from the agricultural and related sectors). It confronts this trend against a counterfactual of what would have happened to the log of total exports had growth rates of total exports remained constant from 2008 onwards and equal to the geometric mean of rates from 2004 to 2007. A significant level effect generated by the 2008 contraction of exports is observed. Data: SCIE, *Quadros de Pessoal*, and *Comércio Internacional*.

Econometric Specification: The thesis estimates whether differentiated exposure to GFC-demand-induced shocks significantly affected firms' short- and long-run outcomes. Namely, it contrasts the responses of labor market and performance outcomes in otherwise similar firms suffering GFC shocks of different intensity. The empirical model follows closely Fernandes and Silva (2020), Yagan (2019), Dix-Carneiro and Kovak (2018), and Autor et al. (2014). To proxy the intensity of the GFC shock for each individual in each region, Yagan (2019) uses the percentage point change in the individual's 2007 commuting zone unemployment rate between 2007 and 2009. He then assesses whether agents living in regions hit harder in terms of higher percentage changes in unemployment were more hurt than their counterparts living in mildly hit regions. Dix-Carneiro and Kovak (2018) do something similar using differentiated exposure

to changes in tariffs across regions and subsequently tracking the evolution of workers' outcomes in regions facing large and small tariff declines. Here, instead of computing the shock at the regional or industrial level, the present thesis computes it at the firm level. The baseline regression is given by

$$y_{tj} = \sum_{t=1}^{T} \beta_t . shock_{j2008} D_t + \boldsymbol{\gamma} \boldsymbol{X}_{j2007} + \nu^{rt} + \iota^{st} + \delta_t + \epsilon_{jt} \qquad (1)$$

where j stands for firms, and t indexes years after the shock. y_{tj} stands for a variety of outcomes specified below. The main regressor of interest is the shock borne by firms. The shock is fixed at its 2008 value but the coefficients (β_t's) are allowed to float freely over time to pin down the effect of the shock as time goes by. As in Yagan (2019), this sequence of $\widehat{\beta_t}$'s is interpreted as the causal impact of the GFC shock on firms' outcomes over time.

The underlying identification assumption behind this model is that the shock is assigned somewhat randomly to firms conditional on their pre-shock characteristics. The analysis controls for pre-trends in the outcome variable (included in vector $\boldsymbol{X}_{j2007}$). If this was not the case, it could be argued that the firms that exhibited worse outcome trajectories were also those that were more prone to be intensely hit in the first place, thereby compromising the inference. To meet the exogeneity requirement, then, it must be assumed that factors relegated to the error term that affect firm outcomes (such as managerial ability, for instance) are uncorrelated with the shock measure, which given the way the shock is computed is plausible. This assures the consistency of the point estimates.

In this specification, δ_t is a drift term meant to control for omitted nationwide time trends, cross-sectional invariant characteristics. ν^{rt} stands for a region-year fixed effect controlling for trends in each firm's baseline region outcomes. This fixed-effect was computed with reference to the broad geographical location of firms according to the Nomenclature of Territorial Units for Statistics at the regional level (NUTS 2). ι^{st} is a two-digit-sector-year fixed effect controlling for trends in each firm's initial two-digit sector outcomes. The sectors employed in the construction of this fixed-effect are those described in Section 3. In fixing the firm's region and sector at baseline, regardless of whether firms moved to other regions or sectors, the thesis closely follows Dix-Carneiro and Kovak's (2018) analogous framework for workers. D_t is a year-dummy variable equal to one in year *t* and zero otherwise for $\forall t \in [2008; 2017]$. $\boldsymbol{X}_{j2007}$ is a vector of regressors meant to control for firm characteristics in pre-shock times. This vector

includes variables such as past growth in pre-shock employment, past growth in the total pre-shock wage bill, firm size at baseline (i.e., number of workers at baseline), and more generally, as mentioned above, past growth in the corresponding left-hand-side variable (except when considering firm exits). The vector also contains an importing dummy (for whether or not the firm imported at baseline).

The rationale for including past growth of the wage bill and past growth of employment is that fast (or slow) growing firms in terms of this variable before the shock might have been expected to have positive (negative) estimates for the relevant coefficients, even in the absence of shock. The inclusion of firm size at baseline and imports at baseline is justified by the possibility of these terms being correlated with shock exposure, while at the same time affecting the outcome variable. The covariates are confined to pre-shock years to prevent the crisis from changing them. Taken together, this set of control variables mitigates the threat of harder hit firms being more exposed to other economic shocks confounded with the shock measure.

Finally, ϵ_{jt} is a disturbance term that captures the unexplained part of the model, with

$$E[\epsilon_{jt}|shock_{j2008}] = 0.$$

This model is estimated via fixed effects estimation, and standard errors are clustered by firms. The rationale for clustering adjustments at the firm level lies with the threat of correlated unobservable characteristics across within-cluster elements. In other words, clustered standard errors are employed because the error terms within groups (firms, regions, industries, and so forth) might be correlated with one another. Here, errors are clustered at the firm level rather than at a more aggregate level, guided by the case put forth by Abadie et al. (2017). Section 6 provides robustness checks by including firm fixed effects in the baseline regression to control for observed and unobserved time-invariant cross-sectional heterogeneity across firms.

Outcomes: When running this model, in most cases, logs of the dependent variable are taken. The justification for this transformation is twofold.[5] On the one hand, log-linear models provide a convenient interpretation for the estimated coefficients in terms of percentage changes. On the other hand, since the natural log of a given variable has a maximum value at $+\infty$ and a minimum at $-\infty$ – unlike the baseline variables (sales, employment etc.) – this transformation avoids employing a limited dependent variable framework. Firms' real revenues are computed

[5] Other justifications for taking logs of the dependent variable include the normalization of the errors with a positively skewed distribution, and the handling of heteroscedasticity by limiting the variance the errors.

as the sum of sales and service provisions (both in real terms). To compute labor productivity z_{jt} in a given firm j in a given year t, gross value added at market prices is divided by the number of workers in that firm. This measure captures how efficiently the firm uses its labor inputs. Value added at market prices is used instead of value added at factor costs to reflect the value that consumers pay in exchange for the firm's production. As an additional measure of productivity, the ratio of revenues over employed people in the company is taken, attempting to best capture the effective creation of value per worker within the firm. In each firm j, in a given year t, total employment L_{jt} results from collapsing worker-level data. The total real wage bill in each firm *j*, in a given year *t*, is computed by taking

$$W_{jt} = \sum_{i=1}^{N} w_{ijt}$$

where w_{ijt} stands for a given worker *i*'s individual real labor earnings. To build w_{ijt}, the worker's base real wage is added to regular and irregular installments (in real terms) and remuneration for extra hours (in real terms). Section 6 shows that the results would still hold for slight variations of the wage bill and employment definitions. Finally, average wages are simply given by

$$\overline{w}_{jt} = L_{jt}^{-1} \sum_{i=1}^{N} w_{ijt}$$

To compute the number of hours worked within the firm, the analysis collapses the number of hours worked inside the company. When investigating whether there are changes in terms of the composition of labor, in Section 5, the analysis uses as the outcome variable the ratio of skilled to unskilled workers within the firm. Finally, firm closure c_{jt} is computed as follows: c_{jt} equals 0 if firm *j* exists in the panel in year t. c_{jt} equals 1 if firm *j* no longer exists in the panel in year t *and* that same firm had a strictly positive number of workers in year $t-1$. Formally,

$$c_{jt} = \mathbb{1}(\mathrm{L_{jt}} = 0 | \mathrm{L_{jt-1}} > 0)$$

For this exercise, the initially unbalanced panel was first balanced and then carefully adjusted to accommodate the fact that some firms only came into existence after 2004. For example, if a firm *j* was born in 2006, saying that *j* closed in 2005 or 2004 would make little sense. Except for this last outcome, for all the other dependent variables, the bottom fifth and top fifth

percentiles were trimmed each year. This was done to avoid having very large outliers driving the results.[6]

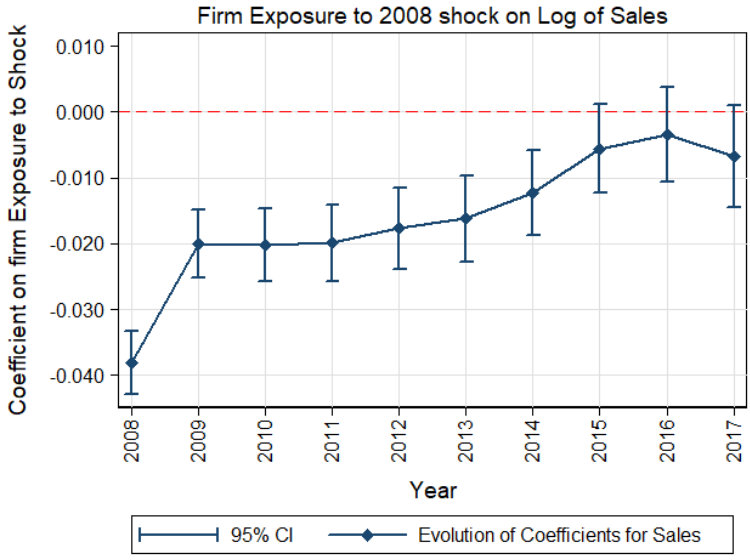
5. Results

A. Impacts of the GFC Induced Demand Shock on Firms

This section presents the main results addressing this first question of the thesis: what were the impacts of differentiated exposure to a GFC-induced demand shock on revenues, the probability of firm exits, and reallocation across markets?

Firm Revenues: How were firm revenues affected by the GFC-crisis induced demand shock? The estimated coefficients of Model (1) presented above are displayed in Figure 2, together with the corresponding 95% confidence intervals based on cluster robust standard errors. Each point in the plot represents the coefficient $\widehat{\beta_t}$ for the respective year.

Figure 2: Impacts of 2008 Shock on Firm Revenues



Note: This figure presents the effects of Portuguese firms' international trade partners' income contraction on log of revenues over time, from 2008 to 2017. Each point to corresponds to a given $\widehat{\beta_t}$ in the respective year coming out of estimating equation (1) by fixed effects estimation. 95% confidence intervals based on clustered robust standard errors at the firm level are also displayed. The sample includes all firms shocked in 2008 meeting our sampling criteria, excluding firms from the agricultural and related sectors. These results cover only firms remaining in panel until *t*.

The regression results are presented in Column 3 in Table 2 in Appendix I. Section 6 shows that these results are robust to the introduction of firm fixed effects. A negative and significant

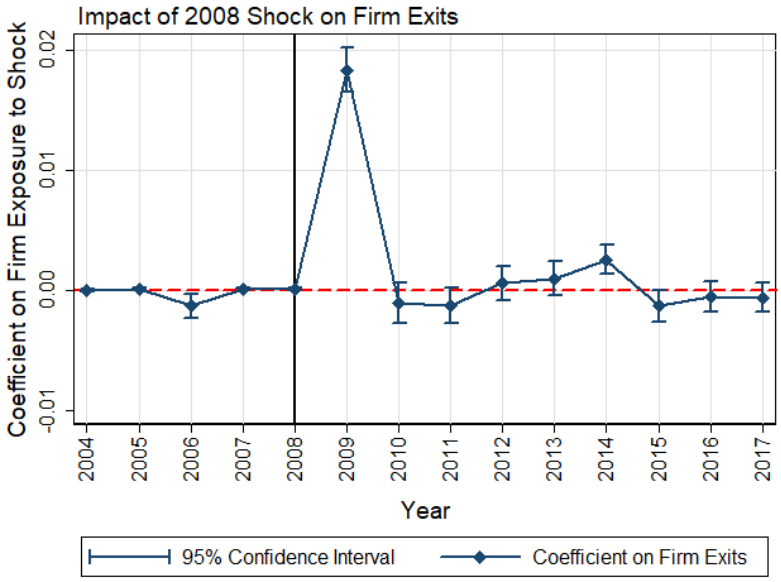
[6] We have verified that the results are robust to trimming at the top and bottom 1%, or no trimming at all.

coefficient would suggest that a contraction in firms' commercial partners' GDP would lead to a decrease in revenues. Importantly, the estimates presented here include only the *intensive* margin of adjustment for firms, in the sense that only firms did not exit the panel at any given point in time were kept. Each coefficient is interpreted as follows: in a given year t, a one-percentage point increase in the intensity of the 2008 shock is estimated to bring about a decrease in revenues of $\widehat{\beta_t} \times 100$ percent. For 2008 for example, a one-percentage point increase in the intensity of the shock led to a contraction in revenues of 3.8 percent (SE 0.24 percent). In 2009, this effect decreased to 2 percent (SE 0.26 percent) and became milder over time as the shock faded away. The effects on revenues last for almost half a decade. Alternatively, following Autor et al. (2014) the analysis evaluates the interquartile implied revenue differential based on the shock distribution. Since according to the data, a mildly hit firm at the 25th percentile of the 2008 shock distribution and a hard hit firm at the 75th percentile of the 2008 shock distribution are 0.89 percentage points apart, the implied differential reduction of revenues amounts to 3.38 percent (3.8*0.89) in 2008. Following Dix-Carneiro and Kovak (2018) instead, the 90-10 gap in shock is compared: since a firm at the 10th percentile of the shock distribution and a firm at the 90th percentile of the shock distribution stand 7.28-percentage points apart, the implied reduction in revenues amounts to 27.6 percent (3.8*7.28) in 2008. These estimates suggest that the 2008 external demand contraction was salient and persistently felt by firms in terms of their revenues. The estimates track very closely Proposition I of the theoretical model that predicted a stronger decline in revenues for harder hit firms. Surprisingly, they do so not only in terms of direction, but also in terms of magnitude: for reasonable values of $\alpha \in (0,1)$, a change of $1/\alpha$ percent in response to a 1 percent higher shock fits well the magnitude of the obtained point estimates.

Firm Exits: Next, the effects on firm exit probability are presented. Figure 3 presents the relevant coefficient and Table 1 in Appendix I presents the complete results of the estimates for equation (1) with firm exits as the dependent variable (with and without firm fixed effects). As in the previous graph, each point in the plot represents coefficient $\widehat{\beta_t}$ for the respective year. A positive and significant coefficient suggests that a contraction in firms' commercial partners' GDP would lead to an increase in the probability of firm closure. In 2009, a one-percentage point increase in the intensity of the 2008 GFC shock is estimated to have increased the probability of firm closure by 1.8 percent (SE 0.1 percent). As shown in Figure 3, the effects of the 2008 GFC shock on firm closures was short-lived, but it was strong and significant in 2009. The introduction of firm fixed effects corroborates the overall trajectory of the coefficients and the

magnitude of the estimated coefficient for 2009. This result is closely aligned with Proposition I of the model developed in Section 2. Given that for firm exits, one is unable to control for the pre-trend of this outcome, the graph includes the placebo coefficients for the pre-period highlighting that they do not exhibit an upward-sloping trajectory. This is reassuring: it cannot be said that positive coefficients for the post-shock periods were expected even in the absence of the shock.

Figure 3: Exposure of Firms in term of Exit Probability to 2008 Shock.



Note: This figure presents the effects of Portuguese firms' commercial partners' income contraction on closure probability, from 2004 to 2017. Each point corresponds to a given $\widehat{\beta_t}$ in the respective year coming out of estimating equation (1) by fixed effects estimation. 95% confidence intervals based on clustered robust standard errors at the firm level are also displayed. The sample includes all firms shocked in 2008 that meet the sampling criteria, excluding firms from the agricultural and related sectors. To run this regression the otherwise unbalanced panel was balanced. The dependent variable assigns a value of zero to a firm present in the panel in a given year and one in case that firm was not present in the panel while having a positive number of workers in the previous year.

Trade Diversion: Do harder hit firms respond to the external demand shock by diverting their exports toward less intensely hit trade partners? To test this hypothesis, trade data from *Comércio Internacional* is used to create an additional variable with the number of export trade partners for each firm. This variable is then merged with the main sample but only those firms exporting at least to one destination at baseline (in 2007)[7] are kept. Afterward, model (1) is run

[7] This adjustment only foregoes firms having a zero value for the shock measure in 2008, since firms exclusively importing, and not exporting at baseline, got a zero percent shock in 2008. The rationale for this selection is that this exercise aims at assessing the impact of the idiosyncratic demand shock on

once more using the number of export destination countries as the dependent variable. The results are presented in Table 2. The coefficients obtained are positive and indicate that for firms exporting at baseline, a 10-percentage point higher GFC external demand 2008 shock is estimated to have led to one additional trade partner in 2009.

Table 2: Estimated Effect of Shock on Number of Trade Partners

	(1)	
	Trade Partners	Std. Deviation
β_{2008}	0.068***	(0.011)
β_{2009}	0.104***	(0.013)
β_{2010}	0.142***	(0.015)
β_{2011}	0.144***	(0.017)
β_{2012}	0.153***	(0.019)
β_{2013}	0.148***	(0.021)
β_{2014}	0.169***	(0.022)
β_{2015}	0.162***	(0.024)
β_{2016}	0.172***	(0.026)
β_{2017}	0.192***	(0.029)
Imports at Baseline	3.182***	(0.189)
Firm Size at Baseline	0.003***	(0.001)
Av. Employment Growth 2004-2007	0.493*	(0.274)
Av. LHS Variable Growth 2004-2007	0.521***	(0.191)
Av. Wage Bill Growth 2004-2007	-0.220	(0.153)
Observations	72,127	
R-squared	0.171	
Firm FE	No	
Year FE	No	
2-digit industry FE	No	
Region FE	No	
2-digit industry X Year FE	Yes	
Region X Year FE	Yes	

Note: This table displays the regression results coming out of equation (1) via fixed effects estimation. The dependent variable is the number of firms' export destination countries. These results encompass only firms exporting at baseline. This justifies the relatively lower number of observations. Clustered robust standard errors (at the firm level) are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** significant at the 5% significance level, and * significant at the 10% significance level.

firms' number of trade partner countries, assuming these firms were exporting anything at all by the time the shock hit.

This result is aligned with Proposition I: the idiosyncratic negative demand shock could be acting to generate a profitability wedge between export destinations, making the outside option enticing for firms. Finally, the steady upward trend exhibited by the coefficient makes sense since it would be expected that firms preserve their already acquired export destinations from one year to the next: the coefficients obtained for year *t* also capture some of the effects for the years before *t*. To corroborate this hypothesis, an export portfolio concentration outcome variable is proposed, along the lines of the Herfindhal-Hirshman Index (HHI), of the form

$$\zeta_{jt} = \sum_{d \in \Omega_{jt}}^{N} \left(\frac{x_{jtd}}{\sum_{d \in \Omega_{jt}}^{N} x_{jtd}} \right)^2 = \sum_{d \in \Omega_{jt}}^{N} \left(\frac{x_{jtd}}{X_{jt}} \right)^2 = \sum_{d \in \Omega_{jt}}^{N} \left(s_{jt}^{x} \right)^2$$

where *d* denotes partner countries, Ω_{jt} stands for firm *j*'s universe of destination countries in year *t*, x_{jtd} denotes firm *j*'s exports toward country *d* in a given year *t*, and $\sum_{d \in \Omega_{jt}}^{N} x_{jtd} = X_{jt}$ denotes total exports of firm *j* in year *t*. By construction, $\zeta_{jt} \in [0; 1]$. The closer ζ_{jt} is to one, the *less* diversified the firm's exports are in terms of destinations. Equation (1) is run on the main firm sample using this variable as the outcome, while controlling for its pre-trend growth over 2004–07 along with the usual covariates. The regression results are displayed in Table 13, in Appendix I. The negative and significant coefficients obtained indicate that the 2008 shock induced firms to diversify their export destinations.

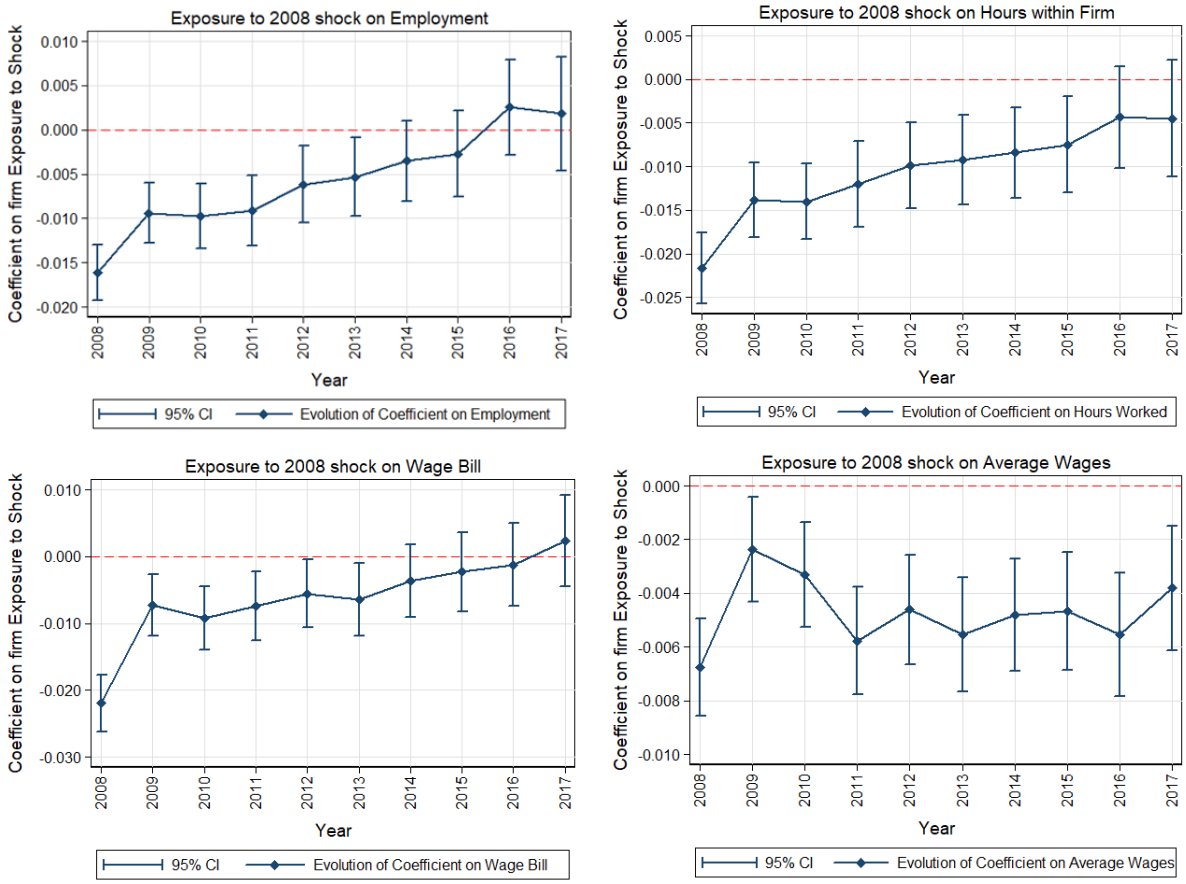
B. Channels of Adjustment to the Crisis

This section presents the results for the second query of the thesis: what were the firms' channels of adjustment to the crisis? Having shown how some firms were driven out of business and others were able to diversify their exports, this section shows how surviving firms reacted to the demand contraction through a variety of margins: labor and non-labor cost-related margins, a technological margin, and ultimately a profitability margin.

Labor Adjustment Margin: This subsection explores the labor-cost margins of adjustment of firms: did firms adjust to the shock by employing fewer workers (extensive margin), fewer hours (intensive margin), lower wages, or a combination of all of the above? Running Model (1) again, the estimated coefficients presented in Figure 4 are obtained. Tables 2 and 3 in Appendix I display these regression results. Section 6 shows how these results are robust to the introduction of firm fixed effects. For employment, firms hit harder by the GFC-induced shock in one percentage point are estimated to have contracted total employment by 1.6 percent (SE 0.15 percent). For total hours, firms hit harder by the GFC-induced shock by 1 percentage point

contracted hourly work by 2.3 percent (SE 0.21 percent). This value decreased to 1.4 percent (SE 0.21 percent) in 2009, but the effects are strongly persistent over time. For the wage bill, a one-percentage point increase in the intensity of the shock is estimated to have led to a contraction in total wages by 2.1 percent (SE 0.21 percent). For average wages, the estimates are negative and significant (although small).

Figure 4: Labor Adjustment Margins: Impacts on firms of 2008 GFC-induced Demand Shock on Employment, Hours Worked, Wage Bill, and Average Wages



Note: This figure presents the effects of Portuguese firms' commercial partners' income contraction on log employment, log hours worked within firm, log wage bill and log average wages, from 2008 to 2017. Each point corresponds to a given $\widehat{\beta}_t$ in the respective year coming out of estimating equation (1) by fixed effects estimation. 95% confidence intervals based on clustered robust standard errors at the firm level are also displayed. The sample includes all firms shocked in 2008 meeting the sampling criteria, excluding firms from the agricultural and related sectors. These results capture only firms existing in the panel until year *t*.

These results not only corroborate the existence of scars generated by the shock on firms, but they also suggest that a combination of labor-cost margins was at play during the GFC crisis. These findings can be rationalized through the lens of Proposition II, which predicted a decline in employment and wage bills in response to a demand shock. Given the obtained elasticities in Section 2, it remains true for this subsection that the model predicts fairly well not only the

direction but also the magnitude of the impacts. A natural follow-up question is whether these effects were also felt at the worker level. To test this hypothesis, equation (1) is rerun but adjusted as

$$e_{ijt} = \sum_{t=1}^{T} \beta_t . shock_{j2008} D_t + \boldsymbol{\gamma X}_{j2007} + \boldsymbol{\Gamma X}_{i2007} + \nu^{rt} + \iota^{st} + \delta_t + \epsilon_{ijt} \qquad (2)$$

where e_{tji} is an indicator that equals one if worker i is in the worker panel in a given year t, and zero otherwise. Equivalently,

$$e_{ijt} = \mathbb{1}(\mathrm{w_{ijt}} > 0)$$

This variable captures employment probability, not job separation. The firm-level vector $\boldsymbol{X}_{j2007}$ includes the same variables described above. $\boldsymbol{X}_{i2007}$ is a worker-level vector including age at baseline, age squared at baseline, a dummy for higher education at baseline, and gender at baseline. ν^{rt}, ι^{st}, and δ_t have the same meaning as before. To perform this exercise, the sample was confined to non-foreign individuals working in a shocked firm as of 2008, between ages 26 and 49 as of 2008 (to prevent them from being artificially unemployed through schooling or retirement). The coefficient β_t in this case captures the differentiated effect on employment probability of the 2008 GFC-induced demand contraction for observationally equal workers working in mildly versus hard hit firms at the time of the shock. In this setting, as in Yagan (2019), the identification assumption is that individuals are seen as randomly assigned to firms *given their baseline characteristics*. If indeed workers were randomly allocated to firms, the *unconditional* witnessed job status differential in panel data could be interpreted as the causal effect of the shock on workers' employment outcome in period T.

$$\beta_T = E\left[Employed_{iT} \middle| Hardly\ Hit_{ji2008} = 1\right] - E\left[Employed_{iT} \middle| Hardly\ Hit_{ji2008} = 0\right]$$

where $Employed_{iT} = \{0,1\}$, and where for simplicity $Hardly\ Hit_{ji2008} = \{0,1\}$. However, in absence of such random assignment, this thesis posits econometrically that the employment status variable is independent of shock intensity, *conditional on baseline firm and worker controls*

$$(Employed_{iT} = 0, Employed_{iT} = 1) \perp Hardly\ Hit_{ji2008} | \boldsymbol{X}_{i2007}, \boldsymbol{X}_{j2007}$$

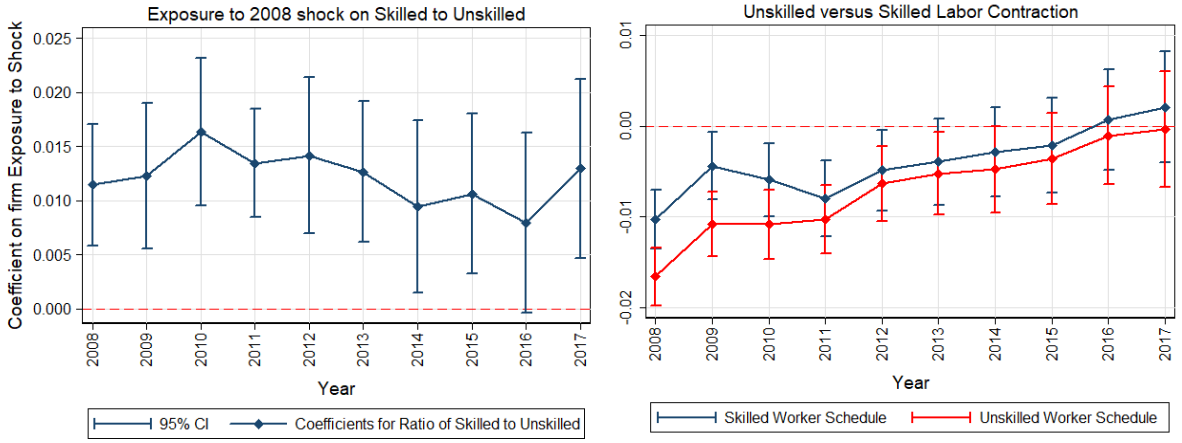
Then, it can be safely concluded that the estimates of the conditional witnessed job status differential in panel data represent the true causal effect of the shock on workers' employment status.

$$\beta_T = E\left[Employed_{iT} \middle| Hardly\ Hit_{ji2008} = 1, \boldsymbol{X}_{i2007}, \boldsymbol{X}_{j2007}\right]$$
$$- E\left[Employed_{iT} \middle| Hardly\ Hit_{ji2008} = 0, \boldsymbol{X}_{i2007}, \boldsymbol{X}_{j2007}\right]$$

The obtained results are presented in Figure A and Table 12 in Appendix I. Workers initially working in firms that were hit one-percentage point harder by the 2008 shock were 1.2 percent (SE 0.001 percent) more likely to be unemployed in 2009 and 2010. These effects decrease over time but are highly persistent. Appendix IV presents the worker-level scarring effects of the shock in terms of (cumulative) average earnings and (cumulative) average hours worked, as well as descriptive statistics for the worker-level panel.

Technological Margin: This subsection addresses the question of whether harder hit firms adjusted the ratio of skilled to unskilled workers. In other words, did harder hit firms lay off disproportionally more unskilled workers? Two exercises are performed. First, the baseline model (1) is run but using instead as outcome variable the ratio of skilled to unskilled workers within the firm. As before, the vector of controls includes the pre-trend past growth of the outcome variable, and the aforementioned covariates. Second, model (1) is re-run considering, first only unskilled, and then only skilled workers separately. These three regressions are displayed in Figure 5. Harder hit firms reduce both the number of skilled workers and unskilled workers.

Figure 5: Labor Adjustments in Composition of Labor: Impacts on Firms of 2008 GFC-induced Demand Shock



Note: This figure presents the effects of Portuguese firms' commercial partners' income contraction on the ratio of skilled to unskilled (left graph), log of unskilled employment (red schedule on the right) and log of skilled employment (blue schedule on graph to the right), from 2008 to 2017. Each point to corresponds to a given $\widehat{\beta_t}$ in the respective year coming out of estimating equation (1) by fixed effects estimation. 95% confidence intervals based on clustered robust standard errors at the firm level are also displayed. The sample includes all firms shocked in 2008 meeting our sampling criteria, excluding firms from the agricultural and related sectors. Firms with no unskilled work are excluded from this last regression (cannot divide a value by zero). These results capture only firms existing in the panel until year *t*.

However, this reduction is steeper for the more unskilled: in 2008, for instance, a one-percentage point increase in exposure to a GFC-induced demand shock leads to a contraction of unskilled labor of 1.7 percent (SE 0.2 percent) but only to a 1 percent (SE 0.16 percent) contraction in skilled labor. This translates into positive coefficients when using the ratio of skilled to unskilled labor as the outcome variable. A one-percentage point increase in exposure to the GFC shock is estimated to have led to an increase in the odds of being skilled rather than unskilled within the firm of about 0.01 in 2008. These results are surprising, but they are nonetheless closely aligned with the prediction of Proposition II of the model, which predicted that adjustments in the composition of labor would occur mainly through downward pressures on unskilled labor.

Non-Labor Costs Adjustment This subsection explores how harder hit firms fared against mildly hit firms in terms of investment and spending on intermediate consumption.

Table 3: 2008 GFC-induced Demand Shock Impacts on Investment and Materials

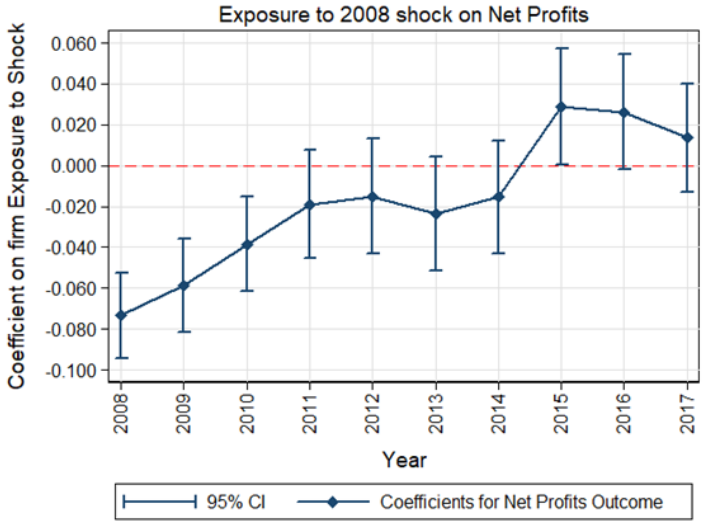
	(1)		(2)	
	Investment	Std. Deviation	Materials	Std. Deviation
β_{2008}	-0.033***	(0.005)	-0.051***	(0.003)
β_{2009}	-0.014**	(0.006)	-0.030***	(0.003)
β_{2010}	-0.013**	(0.005)	-0.027***	(0.003)
β_{2011}	-0.014**	(0.006)	-0.029***	(0.003)
β_{2012}	0.004	(0.006)	-0.028***	(0.004)
β_{2013}	-0.012*	(0.007)	-0.026***	(0.004)
β_{2014}	0.000	(0.007)	-0.022***	(0.004)
β_{2015}	0.016**	(0.007)	-0.017***	(0.004)
β_{2016}	-0.003	(0.007)	-0.014***	(0.004)
β_{2017}	-0.011	(0.007)	-0.015***	(0.004)
Imports at Baseline	0.541***	(0.037)	0.75***	(0.027)
Firm Size at Baseline	0.003***	(0.001)	0.001**	(0.001)
Av. LHS Variable Growth 2004-2007	0.000***	(0.000)	0.000	(0.000)
Av. Wage Bill Growth 2004-2007	0.011	(0.035)	-0.027	(0.033)
Av. Employment Growth 2004-2007	0.070*	(0.043)	-0.054	(0.041)
Observations	75,354		100,842	
R-squared	0.157		0.1482	
Firm FE	No		No	
Year FE	Yes		Yes	
2-digit industry FE	No		No	
Region FE	No		No	
2-digit industry X Year FE	Yes		Yes	
Region X Year FE	Yes		Yes	

Note: This table presents the effects of Portuguese firms' commercial partners' income contraction on log of gross fixed capital formation (left), and log of materials (right) from 2008 to 2017. 95% confidence intervals based on clustered robust standard errors (firm-level) are also displayed in parenthesis. The sample includes all firms shocked in 2008 meeting the sampling criteria, excluding firms from the agricultural and related sectors. The relatively low number of observations is explained by missing values for firms.

These variables are taken directly from SCIE. The investment variable is gross fixed capital formation and intermediate consumption is materials. The caveat of this exercise is that there is a slightly larger number of missing observations. Still, the results (displayed in Table 3) suggest that harder hit firms reacted more elastically in terms of intermediate consumption than in terms of investment: firms that were one-percent harder hit had a 3.3 percent larger decline in investment (SE 0.5 percent), against a differential decline of 5.1 percent (SE 0.3 percent) in materials. However, the price and quantity effects on materials cannot be disentangled. This means that the observed estimates may stem from the passing on of lower prices to other suppliers, a reduction in quantities of materials, or a combination of both.

Profitability This section closes with the evaluation of the effects of GFC-induced demand shocks on firms' profitability. Given that harder hit firms were affected on their revenues, but adjusted through lower costs, the question is whether profits winded up being affected. Model (1) is run again and the estimated coefficients $\widehat{\beta_t}$ are displayed in Figure 4. The regression results are exhibited in column 4 in Table 2 in Appendix I. Harder hit firms were struck harder on their net profits, but these effects were short-lived.

Figure 6: Exposure of Firms in terms of Profitability to 2008 Shock



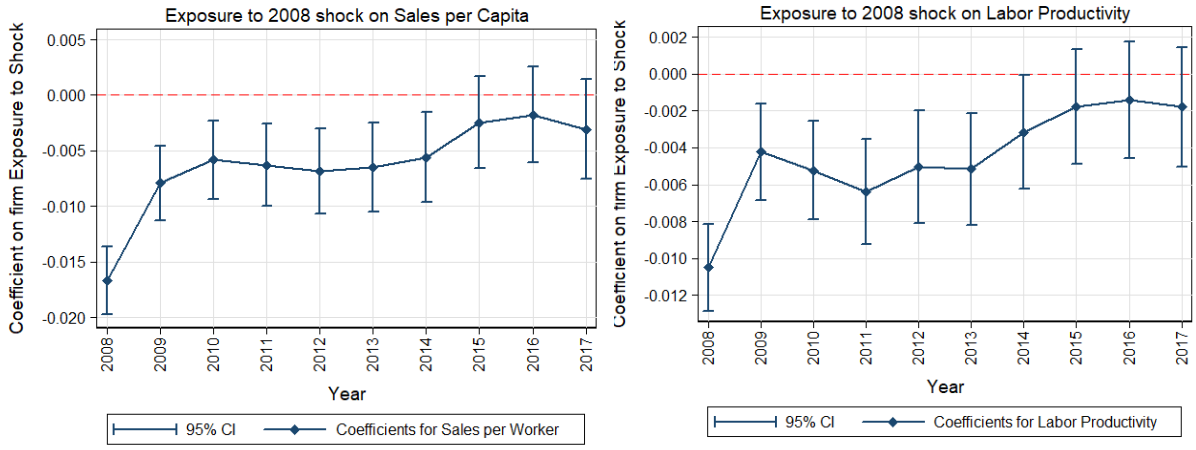
Note: This figure presents the effects of Portuguese firms' commercial partners' income contraction on log of profits, from 2008 to 2017. Each point to corresponds to a given $\widehat{\beta_t}$ in the respective year coming out of estimating equation (1) by fixed effects estimation. 95% confidence intervals based on clustered robust standard errors at the firm level are also displayed. The sample includes all firms shocked in 2008 meeting our sampling criteria, excluding firms from the agricultural and related sectors. When profits were negative or zero, the log of profits were assigned a value of zero. These results cover only firms remaining in panel until *t*.

C. Individual and Aggregate Productivity Effects

This section answers the final question of the thesis: what were the aftermath productivity effects of the crisis at the individual firm level and for the economy as a whole?

Individual Productivity Effects This subsection presents the impacts of a mild *versus* hard GFC-induced demand shock on firm's individual productivity. To start with, it considers two different measures of productivity: real sales per worker, and value added at market prices per worker. Equation (1) is run once more using these two variables as outcomes. Figure 7 below displays the estimated coefficients. As before, each point in these plots represents the coefficient $\widehat{\beta_t}$ for the respective year, together with clustered robust standard errors (clustered at the firm level).

Figure 7: Individual Productivity Effects: Impacts on Firms of 2008 GFC-induced Demand Shock.



Note: This figure presents the effects of firms' commercial partners' income contraction on log of labor productivity (right) and log of sales per capita (left), from 2004 to 2017. Each point corresponds to a given $\widehat{\beta_t}$ in the respective year coming out of estimating equation (1) by fixed effects estimation. 95% confidence intervals based on clustered robust standard errors at the firm level are also displayed. The sample includes all firms shocked in 2008 that meet our sampling construction criteria, excluding firms from the agricultural and related sectors. These results capture only firms existing in the panel until year *t*.

A one-percentage point increase in the intensity of the 2008 shock led to a decrease of labor productivity of 1.05 percent (SE 0.12 percent) in 2008. While falling in magnitude over time, these effects are still present in 2014. This occurs regardless of whether we consider (real) sales per worker or (average) labor productivity. It may seem puzzling that even though the ratio of skilled to unskilled workers went up for harder hit firms their labor productivity went down. However, one lacks a valid counterfactual of what would have happened without the adjustment: perhaps the negative effect on productivity would have been even sharper had the adjustment in the composition of labor not taken place. To complement these individual level

estimates this section considers firms producing according to a decreasing returns to scale production function of the form

$$Y_{jt} \equiv F(L_{jt}, X_{jt}) = A_{jt} L_{jt}^{\alpha} X_{jt}^{\gamma}$$

Where L_{jt} are labor inputs and X_{jt} are intermediate inputs of production (materials), with $\alpha + \gamma < 1$. The goal is to analyze whether harder hit firms display lower levels of A_{jt} relative to their mildly hit counterparts, due to the shock. Using data from SCIE, one is able to extract values for α and γ. Such is possible since it is known that

$$\frac{\partial Y_{jt}}{\partial L_{jt}} \times L_{jt} = \alpha Y_{jt} \underset{MpL=w}{\Longleftrightarrow} w_{jt} \times L_{jt} = \alpha Y_{jt}$$

$$\frac{\partial Y_{jt}}{\partial X_{jt}} \times X_{jt} = \gamma Y_{jt} \underset{MpX=r}{\Longleftrightarrow} r_{jt} \times X_{jt} = \gamma Y_{jt}$$

That is, assuming factors are paid at their marginal products, one can proxy the value of α by the share of total wage bill over total sales, and γ by the share of spending on intermediate consumption on total sales. Table 4 below evaluates what these values represent in the Portuguese economy over time.

Table 4: Estimated Labor, Intermediate Consumption and Capital Share of Income for the Portuguese Economy, from 2004 to 2017.

Year	Labor	Intermediate Consumption	Capital
2004	0.14	0.537	0.322
2005	0.14	0.541	0.319
2006	0.138	0.543	0.32
2007	0.135	0.548	0.317
2008	0.138	0.545	0.317
2009	0.15	0.514	0.336
2010	0.144	0.522	0.334
2011	0.145	0.538	0.318
2012	0.143	0.547	0.31
2013	0.141	0.551	0.308
2014	0.141	0.55	0.309
2015	0.144	0.542	0.314
2016	0.146	0.537	0.317
2017	0.145	0.54	0.316

Note: Own computations using *SCIE data*.

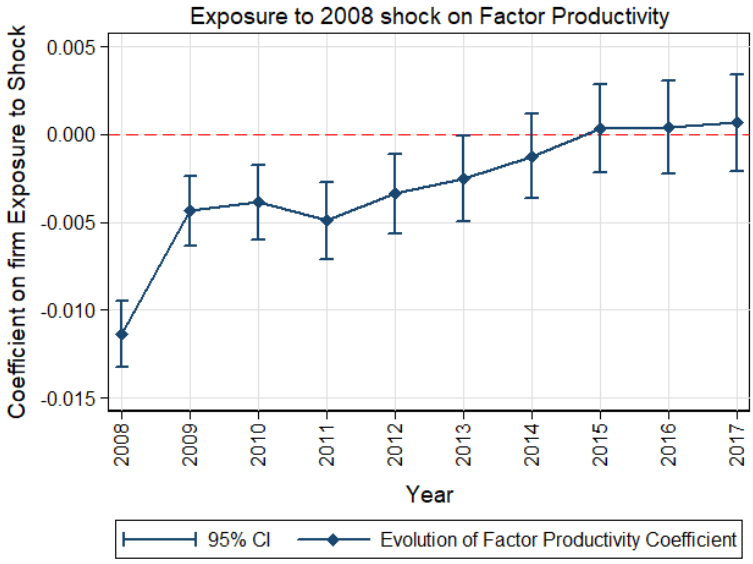
Non-surprisingly, these shares remain broadly constant over time, consistent with standard production functions' assumptions. For sake of simplicity, and given this property, this thesis

assumes $\hat{\alpha} = 0.14$ and $\hat{\gamma} = 0.54$. Table 4 also includes an extracted implicit coefficient for the income share of capital, had one assumed a constant returns to scale function with labor, capital, and intermediate consumption. Unfortunately, there is no readily available measure for capital in SCIE data and thus one is not able to evaluate *total* factor productivity.Equipped with these coefficients, one can log-linearize the Cobb-Douglas function and obtain a more comprehensive productivity measure given by

$$\ln(A_{jt}) = \ln(Y_{jt}) - 0.14 \times \ln(L_{jt}) - 0.54 \times ln\,(X_{jt})$$

Equation (1) is then re-ran using this new variable. Figure 8 displays the estimated coefficients. Complete regression outputs can be found in Table 11 in Appendix I. A one-percentage point increase in the intensity of the 2008 shock is estimated to have led to a decrease of factor productivity of 1.1 percent (SE 0.1 percent) in 2008. These results corroborate the estimates found above, and once again highlight the lasting influences of the GFC initial demand shock.

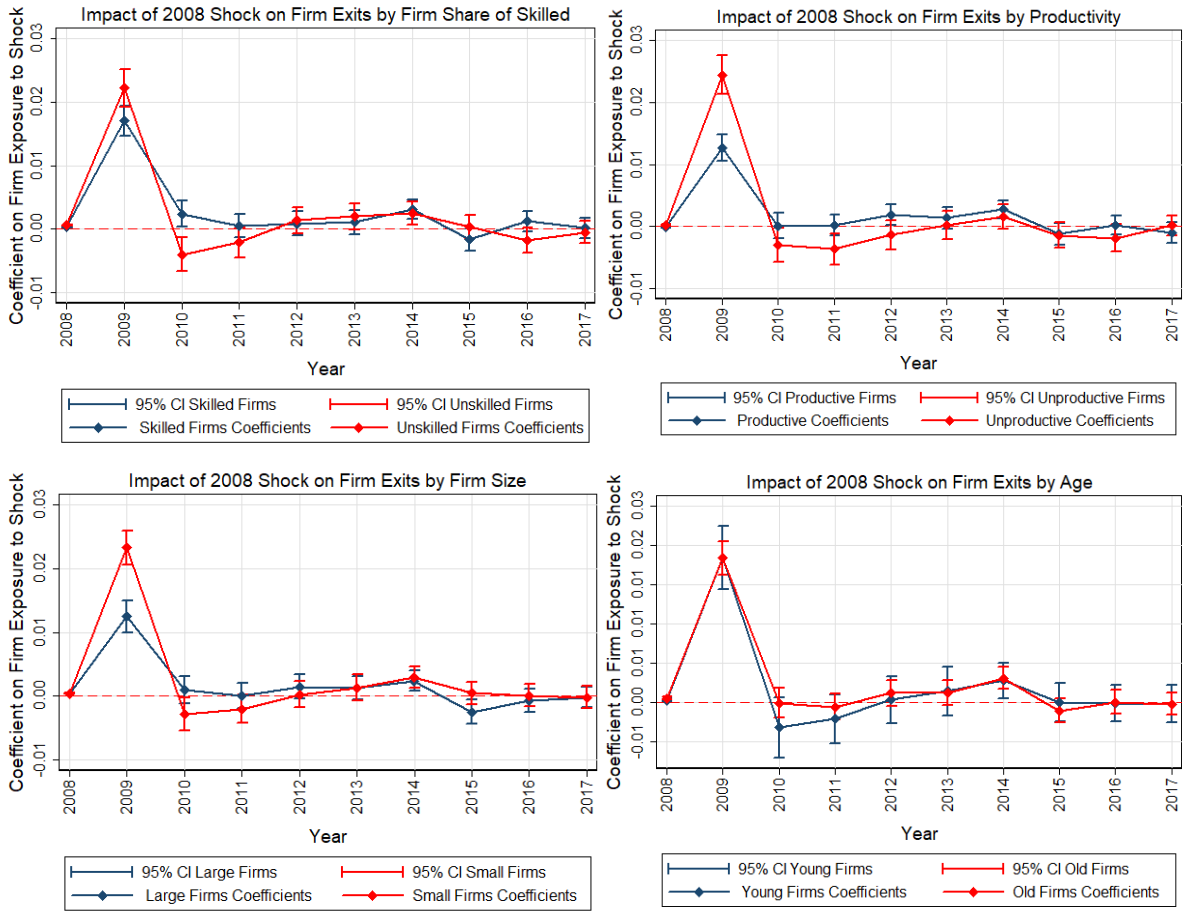
Figure 8: Factor Productivity Effects: Impacts on Firms of 2008 GFC-induced Demand Shock.



Note: This figure presents the effects of income contraction by firms' partners on log of factor productivity, from 2004 to 2017. Each point corresponds to a given $\widehat{\beta_t}$ in the respective year coming out of estimating equation (1) by fixed effects estimation. 95% confidence intervals based on clustered robust standard errors at the firm level are also displayed. The sample includes all firms shocked in 2008 that meet our sampling construction criteria, excluding firms from the agricultural and related sectors. These results capture only firms existing in the panel until year *t*.

Aggregate Productivity and Cleansing Effects Which effect dominated for the Portuguese economy in response to the GFC shock: the "cleansing" or the "insulation effect"? To study this hypothesis, this thesis studies the heterogeneous responses of firms in terms of firm closure probability. This subsection displays the results. The sample is split into subgroups and equation (1) is re-ran. The focus is on the 2009 coefficient. This section considers in turn productivity, the share of skilled workers within the company, firm size, and firm age. To study the relative likelihood of perishing in response to shock exposure depending on the share of skilled workers, this section runs equation (1) separately for firms who had above and below median values for this ratio at baseline. For productivity, the threshold is defined as the median value for value added per worker at baseline. For firm size, a firm with less than sixteen employees at baseline (median value) is considered to be 'small', and considered 'large' otherwise. Finally, firms with less than ten years of existence are deemed 'young', otherwise they are considered 'old'.

Figure 9: Differentiated Impact of Exposure to 2008 Shock Depending on Baseline Characteristics



Note: This panel displays the result of running equation (1) for: (*i*) skill intensive firms and non-skill intensive firms; (*ii*) productive firms and non-productive firms; (*iii*) small firms and large firms; (*iv*) old firms against young firms. All firms meeting the sampling criteria are eligible for this exercise. To run these regressions, the otherwise unbalanced firm level panel was balanced.

Table 6 in the Appendix presents these estimates and Figure 9 presented here plots them graphically. Firms respond differently to the GFC shock in terms of exiting behavior depending on their initial characteristics. In particular, larger, more productive and firms with a higher share of skilled workers are relatively more resilient to the shock in what comes to exiting. There are only small differences to shock exposure depending on firms' age. Zooming in on heterogeneous responses by level of productivity, it is estimated that when faced with a one-percentage point higher GFC shock, unproductive firms are 1.1 percentage points more likely to perish than their productive counterparts are. This finding can be rationalized in light of Proposition III: when faced with a similar idiosyncratic external demand shock, firms with higher idiosyncratic TFP are less likely to step past the shutdown threshold. The fact that initially smaller, less productive firms endowed with scarcer skilled labor are more likely to close leaves open the possibility of cleansing effects for the economy as whole.

6. Robustness Checks

This section performs some robustness checks to the baseline performance and labor market estimates.

Introduction of firm fixed Effects The estimated coefficients for the performance and labor market outcomes are robust to the introduction of firm fixed effects. The coefficients are lower in magnitude but remain statistically significant overall. Tables 7 and 8 in Appendix I show these results. Since the covariates in equation (1) were constant over time for firms, and since firm fixed effects control for time-invariant cross-sectional firm heterogeneity, we do not include our initial vector of regressors in this specification. We are thus estimating the model

$$y_{tj} = \sum_{t=1}^{T} \beta_t . shock_{j2008} D_t + \delta_t + \alpha_j + \nu^{rt} + \iota^{st} + \eta_{jt}$$

Where α_j stands for a firm fixed effect, and the remaining terms have the same meaning as described in Section 4.

Alternative Shock Specification This subsection computes an alternative shock variable that considers only the five largest export destination countries for firms in the sample at baseline. Call such shock for firm *j* in year *t*, $shock'_{jt}$. Formally, for each firm, this alternative shock measure takes, as before, weights of the form

$$w'^{d}_{j2007} = \frac{X^{d}_{j2007}}{\sum_{d=1} X^{d}{}_{j2007}}$$

Only that now, the elements of *d* correspond to the five largest export destinations of each firm at baseline. The new shock variable is computed as

$$shock'_{j2008} - \sum_{d} {w'_{j2007}}^{d} \times g^{d}_{2008}$$

One expects both shock measures to track each other broadly. The reason is that GDP growth rates of more prominent firm export destinations in our shock measure are assigned higher weights by construction. Thus, it is likely that smaller export destinations become irrelevant for our purposes as the number of partner countries grows. Briefly, the looser the restriction on the number of partner countries, the more the alternative shock measure converges to the initial shock specification. For this reason, this robustness section restricts the number of trade partners for each firm to five, to be conservative. Table 9 in Appendix I presents the results of re-running regression (1) using this new exposure measure. The results are strikingly similar to the initial estimates, differing only in a few decimal cases. One hypothesis that can justify these findings is that for the average firm, the number of export destinations is not very large. Thus, the weights assigned to the largest partner countries is substantial, leading to only a few countries' growth rates determining most of the exposure of a given firm in a given year.

Alternative Labor Outcome Specification This subsection focuses on labor market outcome variables, and checks whether our estimates are robust to slight variations of employment and wage bill definitions. Namely, instead of using the baseline *Quadros de Pessoal* labor market variables found by collapsing worker data into firms, this subsection evaluates the crisis impacts using a variety of variables directly extracted from firm-level data (SCIE). It uses as outcomes the following variables: total labor costs, total wage bill (from SCIE), non-wage related labor costs, total employment (SCIE), and total *paid* employment. The obtained point estimates are reassuring: the coefficients for wage bill and employment impacts broadly track the ones found in Section 5. The remaining measures used are of same magnitude and remain statistically significant. The results for these five regressions are presented in Table 10 in the Appendix.

7. Conclusion

This thesis leveraged on differentiated firm exposure to an external GFC-induced demand shock to explore the impacts, persistency-driving channels of adjustment, and the productivity effects of the crisis. It found that firms that were harder hit by one percentage point were 1.8 percent (SE 0.01 percent) more likely to leave the market in 2009, and they were able to diversify their export portfolio in response to the shock. The thesis also showed that harder hit

firms adjusted their labor force composition toward a more skill abundant labor combination. The adjustment of labor occurred through reductions in hours worked and number of workers. In particular, the thesis found that a one-percentage point increase in exposure to the demand shock led to 1.6 percent (SE 0.16 percent) lower employment. Despite its transitory nature, the GFC external shock was felt several years past its initial incidence on revenues, employment, and productivity.

These results challenge the view that the effects of recessions are only felt at business cycle frequency. Rather, this thesis argues that crises generate significant scar tissue for hard hit firms and workers alike, but the observed exit heterogeneity across subgroups in response to the shock leaves open the possibility of aggregate cleansing effects taking place via the survival of more productive firms.

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9. Appendix I

	(1)		(2)	
	Firm Exits	Std. Errors	Firm Exits	Std. Errors
β_{2004}	0.000	(0.000)	0.000	(0.001)
β_{2005}	0.000*	(0.000)	0.000	(0.001)
β_{2006}	-0.001**	(0.001)	0.000	(0.001)
β_{2007}	0.000*	(0.000)	0.004	(0.001)
β_{2008}	0.000*	(0.000)	0.004	(0.001)
β_{2009}	0.018***	(0.001)	0.019***	(0.001)
β_{2010}	-0.001	(0.001)	-0.001	(0.001)
β_{2011}	-0.001	(0.001)	-0.001	(0.001)
β_{2012}	0.001	(0.001)	0.001	(0.001)
β_{2013}	0.001	(0.001)	0.001	(0.001)
β_{2014}	0.003***	(0.001)	0.003***	(0.001)
β_{2015}	-0.001*	(0.001)	-0.001	(0.001)
β_{2016}	-0.001	(0.001)	-0.000	(0.001)
β_{2017}	-0.001	(0.001)	-0.000	(0.001)
Importer Dummy at Baseline	-0.014***	(0.001)		
Firm Size at Baseline	-0.010***	(0.000)		
Av. Employment Growth 2004-2008	-0.006**	(0.004)		
Av. Wage Bill Growth 2004-2008	-0.004*	(0.003)		
Observations	212,747		212,747	
R-squared	0.078		0.127	
Firm FE	No		Yes	
Year FE	Yes		Yes	
2-digit industry FE	No		No	
Region FE	No		No	
2-digit industry X Year FE	Yes		Yes	
Region X Year FE	Yes		Yes	

Table 1: Estimated Impacts of GFC-induced Demand Shock on Exiting Probability

Note: The left-hand side of this table displays the regression outcomes resulting from estimating equation (1) by fixed effect estimation. The right-hand side of this panel displays the same regression with the inclusion of firm fixed-effect instead of the vector of firm level time-invariant covariates. The sample includes all firms shocked in 2008, excluding firms from the agricultural and related sectors. The dependent variable in this regression was computed by assigning a value of zero to a firm present in the panel in a given year and one in case that firm was no longer present in the panel given that such firm was present in the previous year. Clustered robust standard errors (clustered at the firm level) are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** designates a variable significant at the 5% significance level, and * designates a variable significant at the 10% significance level. To run these regressions we had to balance our otherwise unbalanced panel, hence the larger number of observations. No trimming was performed on the outcome variable, as it would make little sense in this case.

	(1) Wage Bill (log)	(2) Av. Wages (log)	(3) Sales (log)	(4) Net Profits (log)
β_{2008}	-0.022***	-0.007***	-0.038***	-0.073***
	(0.002)	(0.001)	(0.002)	(0.011)
β_{2009}	-0.007***	-0.002**	-0.020***	-0.058***
	(0.002)	(0.001)	(0.003)	(0.012)
β_{2010}	-0.009***	-0.003***	-0.020***	-0.038***
	(0.002)	(0.001)	(0.003)	(0.013)
β_{2011}	-0.007***	-0.006***	-0.020***	-0.019
	(0.003)	(0.001)	(0.003)	(0.014)
β_{2012}	-0.006**	-0.005***	-0.018***	-0.015
	(0.003)	(0.001)	(0.003)	(0.014)
β_{2013}	-0.006**	-0.006***	-0.016***	-0.023
	(0.003)	(0.001)	(0.003)	(0.014)
β_{2014}	-0.004	-0.005***	-0.012***	-0.015
	(0.003)	(0.001)	(0.003)	(0.014)
β_{2015}	-0.002	-0.005***	-0.006	0.028**
	(0.003)	(0.001)	(0.003)	(0.015)
β_{2016}	-0.001	-0.006***	-0.003	0.026*
	(0.003)	(0.001)	(0.004)	(0.016)
β_{2017}	0.002	-0.004***	-0.007*	0.013
	(0.004)	(0.001)	(0.004)	(0.013)
Av. Employment Growth Rate 2004-2007	0.083***	0.006	0.076***	-0.10
	(0.025)	(0.006)	(0.028)	(0.075)
Imports at Baseline	0.312***	0.139***	0.524***	0.79***
	(0.019)	(0.007)	(0.028)	(0.065)
Av. Wage Bill Growth 2004-2007	-0.032**	-0.001	-0.020	0.17***
	(0.016)	(0.005)	(0.021)	(0.058)
Firm Size at Baseline	0.015***	0.000	0.007***	-0.001
	(0.000)	(0.000)	(0.001)	(0.001)
Av. Sales Growth 2004-2007			0.001*	
			(0.001)	
Av. Profits Growth 2004-2007				0.001
				(0.000)
Observations	108,176	108,176	108,140	108,174
R-squared	0.512	0.183	0.286	0.067
Firm FE	No	No	No	No
Year FE	Yes	Yes	Yes	Yes
2-digit industry FE	No	No	No	No
Region FE	No	No	No	No
2-digit industry X Year FE	Yes	Yes	Yes	Yes
Region X Year FE	Yes	Yes	Yes	Yes

Table 2: Impact of 2008 GFC-induced Demand Shock on Wage Bill, Average Wages, Sales and Net Profits

Note: This table displays the regression outcomes resulting from estimating equation (1) by fixed effect estimation for four different indicators: wage bill, average wages, net profits and real revenues. The sample includes all firms shocked in 2008 that meet our exclusion criteria, excluding firms from the agricultural and related sectors. Clustered robust standard errors (clustered at the firm level) are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** designates a variable significant at the 5% significance level, and * designates a variable significant at the 10% significance level. Outcomes were trimmed at the upper 5% and lower 5%. If a given firm has negative or zero profits, we replace our dependent variable by zero. These effects capture only the effects for firms alive until year *t*.

	(1)		(2)	
	Employment (log)	Std. Error	Hours within Firm (log)	Std. Error
β_{2008}	-0.017***	(0.002)	-0.024***	(0.002)
β_{2009}	-0.010***	(0.002)	-0.014***	(0.002)
β_{2010}	-0.010***	(0.002)	-0.014***	(0.002)
β_{2011}	-0.010***	(0.002)	-0.012***	(0.003)
β_{2012}	-0.007***	(0.002)	-0.010***	(0.003)
β_{2013}	-0.006**	(0.002)	-0.009***	(0.003)
β_{2014}	-0.004*	(0.002)	-0.009***	(0.003)
β_{2015}	-0.003	(0.003)	-0.007**	(0.003)
β_{2016}	0.002	(0.003)	-0.004	(0.003)
β_{2017}	0.003	(0.003)	-0.004	(0.003)
Imports at Baseline	0.192***	(0.018)	0.261***	(0.020)
Av. Wage Bill Growth 2004-2007	-0.029*	(0.015)	-0.055***	(0.016)
Av. Total Hours Growth 2004-2007			0.011**	(0.004)
Firm Size at Baseline	0.015***	(0.001)	0.013***	(0.001)
Av. Employment Growth 2004-2007	0.078***	(0.026)	0.092***	(0.027)
Observations	108,176		108,176	
R-squared	0.585		0.488	
Firm FE	No		No	
Year FE	Yes		Yes	
2-digit industry FE	No		No	
Region FE	No		No	
2-digit industry X Year FE	Yes		Yes	
Region X Year FE	Yes		Yes	

Table 3: Impact of 2008 GFC-induced Demand Shock on Employment and Hours Worked within Firm.

Note: This table displays the regression outcomes resulting from estimating equation (1) by fixed effect estimation for two different indicators: employment and hours worked by workers within firm. The sample includes all firms shocked in 2008 that meet our exclusion criteria, excluding firms from the agricultural and related sectors. Clustered robust standard errors (clustered at the firm level) are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** designates a variable significant at the 5% significance level, and * designates a variable significant at the 10% significance level. Outcomes were trimmed at the upper 5% and lower 5%. If a given firm has negative or zero profits, we replace the dependent variable by zero. These effects capture only the effects for firms alive until year *t*.

	(1) Skilled Employment (log)	(2) Unskilled Employment (log)	(3) Skilled to Unskilled
β_{2008}	-0.010***	-0.017***	0.011***
	(0.002)	(0.002)	(0.003)
β_{2009}	-0.004**	-0.011***	0.012***
	(0.002)	(0.002)	(0.003)
β_{2010}	-0.006***	-0.011***	0.016***
	(0.002)	(0.002)	(0.003)
β_{2011}	-0.008***	-0.010***	0.013***
	(0.002)	(0.002)	(0.003)
β_{2012}	-0.005**	-0.006***	0.014***
	(0.002)	(0.002)	(0.004)
β_{2013}	-0.004	-0.005**	0.013***
	(0.002)	(0.002)	(0.003)
β_{2014}	-0.003	-0.005**	0.009**
	(0.002)	(0.002)	(0.004)
β_{2015}	-0.002	-0.004	0.011***
	(0.003)	(0.003)	(0.004)
β_{2016}	0.001	-0.001	0.008*
	(0.003)	(0.003)	(0.004)
β_{2017}	0.002	-0.000	0.013***
	(0.003)	(0.003)	(0.004)
Imports at Baseline	0.259***	0.152***	0.015
	(0.016)	(0.016)	(0.032)
Av. Wage Bill Growth 2004-2007	0.007	0.015**	0.023
	(0.005)	(0.006)	(0.022)
Firm Size at Baseline	0.011***	0.017***	-0.000***
	(0.000)	(0.000)	(0.000)
Av. Employment Growth 2004-2007			0.004
			(0.022)
Av. Skilled to Unskilled Growth 2004-2007			0.117***
			(0.042)
Av. Skilled Employment Growh 2004-2007	2.697***		
	(0.122)		
Av. Unskilled Employment Growth 2004-2007		0.186***	
		(0.055)	
Observations	108,176	108,176	81,451
R-squared	0.384	0.593	0.113
Firm FE	No	No	No
Year FE	Yes	Yes	Yes
2-digit industry FE	No	No	No
Region FE	No	No	No
2-digit industry X Year FE	Yes	Yes	Yes
Region X Year FE	Yes	Yes	Yes

Table 4: Impact of 2008 GFC-induced Demand Shock on Skilled Employment, Unskilled Employment and the Ratio of Skilled to Unskilled Workers.

Note: This table displays the regression outcomes resulting from estimating equation (1) by fixed effect estimation for three different indicators: skilled employment, unskilled employment and the skilled to unskilled ratio within the firm. The sample includes all firms shocked in 2008 that meet our exclusion criteria, excluding firms from the agricultural and related sectors. Clustered robust standard errors (clustered at the firm level) are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** designates a variable significant at the 5% significance level, and * designates a variable significant at the 10% significance level. Outcomes were trimmed at the upper 5% and lower 5% (expect for the ratio of skilled to unskilled). The lower number of observations for the last regression is justified by the exclusion of firms having zero unskilled workers. These effects capture only the effects for firms alive until year *t*.

	(1)		(2)	
	Sales per Worker (log)	Std. Errors	Labor Productivity (log)	Std. Errors
β_{2008}	-0.017***	(0.002)	-0.010***	(0.001)
β_{2009}	-0.008***	(0.002)	-0.004***	(0.001)
β_{2010}	-0.006***	(0.002)	-0.005***	(0.001)
β_{2011}	-0.006***	(0.002)	-0.006***	(0.001)
β_{2012}	-0.007***	(0.002)	-0.005***	(0.002)
β_{2013}	-0.006***	(0.002)	-0.005***	(0.002)
β_{2014}	-0.006***	(0.002)	-0.003**	(0.002)
β_{2015}	-0.002	(0.002)	-0.002	(0.002)
β_{2016}	-0.002	(0.002)	-0.001	(0.002)
β_{2017}	-0.003	(0.002)	-0.002	(0.002)
Imports at Baseline Dummy	0.219***	(0.015)	0.191***	(0.010)
Av. Wage Bill Growth 2004-2007	0.029**	(0.012)	0.025***	(0.008)
Av. Sales per worker Growth 2004-2007	0.001***	(0.000)		
Firm Size at Baseline	0.000	(0.000)	-0.000	(0.000)
Average Employment Growth 2004-2007	-0.036**	(0.016)	-0.020**	(0.009)
Average productivity Growth 2004-2007			0.000**	(0.000)
Observations	108,132		108,172	
R-squared	0.189		0.156	
Firm FE	No		No	
Year FE	Yes		Yes	
2-digit industry FE	No		No	
Region FE	No		No	
2-digit industry X Year FE	Yes		Yes	
Region X Year FE	Yes		Yes	

Table 5: Impact of 2008 GFC-induced Demand Shock on Labor Productivity Variables

Note: This table displays the regression outcomes resulting from estimating equation (1) by fixed effect estimation for two different indicators: sales per worker and labor productivity using value added. The sample includes all firms shocked in 2008 that meet our exclusion criteria, excluding firms from the agricultural and related sectors. Clustered robust standard errors (clustered at the firm level) are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** designates a variable significant at the 5% significance level, and * designates a variable significant at the 10% significance level. Outcomes were trimmed at the upper 5% and lower 5%. These effects capture only the effects for firms alive until year *t*.

	(1) Productive	(2) Non-productive	(3) Large	(4) Small	(5) Skilled	(6) Non-Skilled	(7) Young	(8) Old
β_{2008}	-0.000**	0.000*	0.000**	0.000***	-0.000***	0.000***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
β_{2009}	0.013***	0.024***	0.012***	0.023***	0.016***	0.022***	0.018***	0.018***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
β_{2010}	0.000	-0.003**	0.001	-0.003**	0.002*	-0.004***	-0.003*	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
β_{2011}	0.000	-0.004***	-0.000	-0.002**	-0.000	-0.002**	-0.002	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
β_{2012}	0.002**	-0.001	0.001	0.000	0.000	0.001	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
β_{2013}	0.001	0.000	0.001	0.001	0.000	0.002	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
β_{2014}	0.003***	0.002	0.002***	0.003***	0.002***	0.002**	0.003**	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
β_{2015}	-0.001	-0.001	-0.003***	0.000	-0.002**	0.000	-0.000	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
β_{2016}	0.000	-0.002*	-0.001	-0.000	0.001	-0.002**	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
β_{2017}	-0.001	0.000	-0.000	-0.000	-0.000	-0.001	-0.000	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Imports at Baseline	-0.019***	-0.009***	-0.021***	-0.013***	-0.018***	-0.015***	-0.010***	-0.016***
	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.004)	(0.002)
Firm Size at Baseline	-0.012***	-0.012***	-0.013***	-0.011***	-0.012***	-0.012***	-0.012***	-0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Av. Employment Growth 2004-07	-0.010	-0.010*	-0.009	-0.007	-0.006	-0.009	-0.002	-0.008
	(0.006)	(0.006)	(0.007)	(0.005)	(0.006)	(0.006)	(0.006)	(0.007)
Av. Wage Bill Growth 2004-2007	-0.003	-0.003	-0.006	-0.004	-0.004	-0.005	-0.008*	-0.004
	(0.004)	(0.005)	(0.006)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)
Observations	82,951	82,247	84,678	80,531	82,665	82,555	43,285	114,356
R-squared	0.044	0.104	0.047	0.093	0.053	0.090	0.082	0.060
Firm FE	No	No	No	No	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2-digit industry FE	No	No	No	No	No	No	No	No
Region FE	No	No	No	No	No	No	No	No
2-digit industry X Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region X Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: Heterogeneous Estimated 2008 Shock Impacts on Closure Probability.

Note: This table displays the regression outcomes resulting from estimating equation (1) by fixed effect estimation for different population sub-groups: skilled firms at baseline (those having above median share of skilled workers) and non-skilled otherwise. High productivity firms (above median values of baseline productivity) and non-productive otherwise. Small firm (less than or equal to 16 (median value) workers at baseline) and large firms otherwise, and finally young (less than 10 years old) and old otherwise. The samples include firms shocked in 2008 that meet our sampling criteria, excluding firms from the agricultural and related sectors. Clustered robust standard errors (clustered at the firm level) are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** designates a variable significant at the 5% significance level, and * designates a variable significant at the 10% significance level. To run the regressions we balanced our otherwise unbalanced panel.

	(1) Productivity (log)	(2) Sales per Capita (log)	(3) Net Profits (log)	(4) Sales (log)
β_{2008}	-0.025***	-0.018***	-0.060***	-0.031***
	(0.006)	(0.003)	(0.017)	(0.003)
β_{2009}	-0.033***	-0.018***	-0.075***	-0.031***
	(0.006)	(0.002)	(0.017)	(0.003)
β_{2010}	-0.023***	-0.012***	-0.045***	-0.024***
	(0.006)	(0.002)	(0.017)	(0.003)
β_{2011}	-0.024***	-0.013***	-0.025	-0.022***
	(0.006)	(0.002)	(0.018)	(0.003)
β_{2012}	-0.014**	-0.011***	-0.014	-0.020***
	(0.007)	(0.002)	(0.018)	(0.003)
β_{2013}	-0.021***	-0.011***	-0.016	-0.017***
	(0.006)	(0.003)	(0.018)	(0.003)
β_{2014}	-0.020***	-0.011***	-0.027	-0.016***
	(0.006)	(0.002)	(0.017)	(0.003)
β_{2015}	-0.008	-0.004*	0.022	-0.007***
	(0.006)	(0.002)	(0.016)	(0.003)
β_{2016}	-0.003	-0.003	0.034**	-0.002
	(0.006)	(0.002)	(0.016)	(0.002)
β_{2017}	-0.005	-0.003	0.004	-0.002
	(0.006)	(0.002)	(0.014)	(0.002)
Observations	120,195	120,195	120,195	120,195
R-squared	0.477	0.870	0.529	0.926
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
2-digit industry FE	No	No	No	No
Region FE	No	No	No	No
2-digit industry X Year FE	Yes	Yes	Yes	Yes
Region X Year FE	Yes	Yes	Yes	Yes

Table 7: Estimated 2008 GFC-induced Demand Shock Impact on Selected Performance variables.

Note: This table displays the regression outcomes resulting from estimating equation (1) by fixed effect estimation for four different performance indicators. We include firm fixed effects. The sample includes all firms shocked in 2008 that meet our sampling criteria, excluding firms from the agricultural and related sectors. Clustered robust standard errors (clustered at the firm level) are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** designates a variable significant at the 5% significance level, and * designates a variable significant at the 10% significance level. These effects capture only firms existing in the panel until year *t.* In these regressions, we have not trimmed the outliers. For net profits, we replaced the log of profits by zero when profits were negative or zero. Real sales include both services and goods sold. The relatively higher value for the R squared was expected given the introduction of firm fixed effects.

	(1)	(2)	(3)	(4)
	Wage Bill (log)	Av. Wages (log)	Employment (log)	Hours (log)
β_{2008}	-0.015***	-0.003**	-0.013***	-0.012***
	(0.002)	(0.001)	(0.002)	(0.002)
β_{2009}	-0.015***	-0.002*	-0.013***	-0.013***
	(0.002)	(0.001)	(0.002)	(0.002)
β_{2010}	-0.013***	-0.002**	-0.011***	-0.011***
	(0.002)	(0.001)	(0.002)	(0.002)
β_{2011}	-0.010***	-0.002*	-0.009***	-0.008***
	(0.002)	(0.001)	(0.002)	(0.002)
β_{2012}	-0.010***	-0.002	-0.008***	-0.008***
	(0.002)	(0.001)	(0.002)	(0.002)
β_{2013}	-0.008***	-0.002**	-0.006***	-0.005**
	(0.002)	(0.001)	(0.002)	(0.002)
β_{2014}	-0.007***	-0.002*	-0.005***	-0.004**
	(0.002)	(0.001)	(0.001)	(0.002)
β_{2015}	-0.005***	-0.002*	-0.003**	-0.002
	(0.002)	(0.001)	(0.001)	(0.002)
β_{2016}	-0.001	-0.002**	0.001	-0.000
	(0.002)	(0.001)	(0.001)	(0.002)
β_{2017}	0.001	-0.000	0.001	0.002
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	120,195	120,195	120,195	120,195
R-squared	0.956	0.862	0.962	0.935
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
2-digit industry FE	No	No	No	No
Region FE	No	No	No	No
2-digit industry X Year FE	Yes	Yes	Yes	Yes
Region X Year FE	Yes	Yes	Yes	Yes

Table 8: Estimated 2008 GFC-induced Demand Shock Impact on Selected Labor Market variables.

Note: This table displays the regression outcomes resulting from estimating equation (1) by fixed effect estimation for four different labor market indicators. We include firm fixed effects. The sample includes all firms shocked in 2008 that meet our sampling criteria, excluding firms from the agricultural and related sectors. Clustered robust standard errors (clustered at the firm level) are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** designates a variable significant at the 5% significance level, and * designates a variable significant at the 10% significance level. These effects capture only firms existing in the panel until year *t.* In these regressions, we have not trimmed the outliers. The relatively higher value for the R squared was expected given the introduction of firm fixed effects.

	(1) Wage Bill (log)	(2) Av. Wages (log)	(3) Sales (log)	(4) Net Profits (log)
β_{2008}	-0.022***	-0.007***	-0.038***	-0.073***
	(0.002)	(0.001)	(0.002)	(0.011)
β_{2009}	-0.007***	-0.002**	-0.020***	-0.058***
	(0.002)	(0.001)	(0.003)	(0.012)
β_{2010}	-0.009***	-0.003***	-0.020***	-0.038***
	(0.002)	(0.001)	(0.003)	(0.013)
β_{2011}	-0.007***	-0.006***	-0.020***	-0.019
	(0.003)	(0.001)	(0.003)	(0.014)
β_{2012}	-0.006**	-0.005***	-0.018***	-0.015
	(0.003)	(0.001)	(0.003)	(0.014)
β_{2013}	-0.006**	-0.006***	-0.016***	-0.023
	(0.003)	(0.001)	(0.003)	(0.014)
β_{2014}	-0.004	-0.005***	-0.012***	-0.015
	(0.003)	(0.001)	(0.003)	(0.014)
β_{2015}	-0.002	-0.005***	-0.006	0.028**
	(0.003)	(0.001)	(0.003)	(0.015)
β_{2016}	-0.001	-0.006***	-0.003	0.026*
	(0.003)	(0.001)	(0.004)	(0.016)
β_{2017}	0.002	-0.004***	-0.007*	0.013
	(0.004)	(0.001)	(0.004)	(0.013)
Av. Employment Growth Rate 2004-2007	0.083***	0.006	0.076***	-0.10
	(0.025)	(0.006)	(0.028)	(0.075)
Imports at Baseline	0.312***	0.139***	0.524***	0.79***
	(0.019)	(0.007)	(0.028)	(0.065)
Av. Wage Bill Growth 2004-2007	-0.032**	-0.001	-0.020	0.17***
	(0.016)	(0.005)	(0.021)	(0.058)
Firm Size at Baseline	0.015***	0.000	0.007***	-0.001
	(0.000)	(0.000)	(0.001)	(0.001)
Av. Sales Growth 2004-2007			0.001*	
			(0.001)	
Av. Profits Growth 2004-2007				0.001
				(0.000)
Observations	108,176	108,176	108,140	108,174
R-squared	0.512	0.183	0.286	0.067
Firm FE	No	No	No	No
Year FE	Yes	Yes	Yes	Yes
2-digit industry FE	No	No	No	No
Region FE	No	No	No	No
2-digit industry X Year FE	Yes	Yes	Yes	Yes
Region X Year FE	Yes	Yes	Yes	Yes

Table 9: Impact of Alternative 2008 GFC-induced Demand Shock on Wage Bill, Average Wages, Sales and Net Profits

Note: This table displays the regression outcomes resulting from estimating equation (1) by fixed effect estimation for four different indicators: wage bill, average wages, net profits and real revenues. In this regression we consider only the 5 main commercial partners of each firm when computing the shock. The sample includes all firms shocked in 2008 that meet our exclusion criteria, excluding firms from the agricultural and related sectors. Clustered robust standard errors (clustered at the firm level) are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** designates a variable significant at the 5% significance level, and * designates a variable significant at the 10% significance level. Outcomes were trimmed at the upper 5% and lower 5%. If a given firm has negative or zero profits, we replace our dependent variable by zero. These effects capture

	(1) Total Labor Costs	(2) Wage Bill	(3) Other Labor Costs	(4) Employment	(5) Paid Employment
β_{2008}	-0.022***	-0.022***	-0.021***	-0.016***	-0.016***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
β_{2009}	-0.009***	-0.009***	-0.008***	-0.009***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
β_{2010}	-0.010***	-0.011***	-0.009***	-0.011***	-0.011***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
β_{2011}	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
β_{2012}	-0.008***	-0.008***	-0.009***	-0.007***	-0.007***
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
β_{2013}	-0.007***	-0.007***	-0.009***	-0.007***	-0.007***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
β_{2014}	-0.004	-0.004*	-0.004	-0.005**	-0.005**
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
β_{2015}	-0.004	-0.004	-0.003	-0.003	-0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
β_{2016}	-0.003	-0.003	-0.003	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
β_{2017}	-0.001	-0.000	-0.001	0.002	0.002
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)
Imports at Baseline Dummy	0.301***	0.303***	0.314***	0.189***	0.189***
	(0.017)	(0.017)	(0.018)	(0.018)	(0.018)
Av. LHS Variable Growth 04-07	0.001	0.001	0.000		
	(0.001)	(0.001)	(0.001)		
Firm Size at Baseline	0.014***	0.014***	0.014***	0.015***	0.015***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Av. Employment Growth 2004-2007	0.042***	0.043***	0.042***	0.079***	0.079***
	(0.010)	(0.010)	(0.009)	(0.026)	(0.026)
Av. Wage Bill Growth 2004-2007				-0.030*	-0.030*
				(0.015)	(0.015)
Observations	108,169	108,169	108,143	108,176	108,176
R-squared	0.528	0.522	0.513	0.591	0.591
Firm FE	No	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes
2-digit industry FE	No	No	No	No	No
Region FE	No	No	No	No	No
2-digit industry X Year FE	Yes	Yes	Yes	Yes	Yes
Region X Year FE	Yes	Yes	Yes	Yes	Yes

Table 10: Estimated 2008 GFC-induced Demand Shock Impact on Selected Labor Market variables (SCIE).

Note: This table displays the regression outcomes resulting from estimating equation (1) by fixed effect estimation for five different labor market indicators stemming directly from SCIE. The sample includes all firms shocked in 2008 that meet our sampling criteria, excluding firms from the agricultural and related sectors. Clustered robust standard errors (clustered at the firm level) are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** designates a variable significant at the 5% significance level, and * designates a variable significant at the 10% significance level. These effects capture only firms existing in the panel until year *t.* All dependent variables are in logs. Outcomes were trimmed at the upper 5% and lower 5%. These effects capture only the effects for firms alive until year *t*.

	(1)	
	Factor Productivity (log)	Std. Deviation
β_{2008}	-0.011***	(0.001)
β_{2009}	-0.004***	(0.001)
β_{2010}	-0.004***	(0.001)
β_{2011}	-0.005***	(0.001)
β_{2012}	-0.003***	(0.001)
β_{2013}	-0.003**	(0.001)
β_{2014}	-0.001	(0.001)
β_{2015}	0.000	(0.001)
β_{2016}	0.000	(0.001)
β_{2017}	0.001	(0.001)
Imports at Baseline Dummy	0.147***	(0.010)
Av. Employment Growth 2004-2007	0.031***	(0.011)
Firm Size at Baseline	0.002***	(0.000)
Av. Wage Bill Growth 2004-2007	-0.007	(0.008)
Av. Factor Productivity Growth 2004-2007	0.014**	(0.007)
Observations	98,640	
R-squared	0.285	
Firm FE	No	
Year FE	Yes	
2-digit industry FE	No	
Region FE	No	
2-digit industry X Year FE	Yes	
Region X Year FE	Yes	

Table 11: Impact of 2008 GFC-induced Demand Shock on Factor Productivity

Note: This table displays the regression outcomes resulting from estimating equation (1) by fixed effect estimation for factor productivity based on sales. The sample includes all firms shocked in 2008 that meet our exclusion criteria, excluding firms from the agricultural and related sectors. Clustered robust standard errors (clustered at the firm level) are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** designates a variable significant at the 5% significance level, and * designates a variable significant at the 10% significance level. Outcomes were trimmed at the upper 5% and lower 5%. These effects capture only the effects for firms alive until year *t*.

	(1)	
	Employment	Std. Errors
β_{2008}	-0.002***	(0.000)
β_{2009}	-0.012***	(0.000)
β_{2010}	-0.012***	(0.000)
β_{2011}	-0.007***	(0.000)
β_{2012}	-0.006***	(0.000)
β_{2013}	-0.006***	(0.000)
β_{2014}	-0.007***	(0.000)
β_{2015}	-0.006***	(0.000)
β_{2016}	-0.005***	(0.000)
β_{2017}	-0.002***	(0.000)
Baseline Age of Worker	0.022***	(0.000)
Baseline Squared Age of Worker	-0.000***	(0.000)
Baseline Gender of Worker	0.043***	(0.001)
Dummy for higher education at baseline	0.020***	(0.001)
Av. Employment Growth 2004-2007 (Firm-level)	-0.000***	(0.000)
Av. Wage Bill Growth 2004-2007 (Firm-level)	0.000***	(0.000)
Worker's Baseline Firm Size at Baseline	0.000***	(0.000)
Worker's Baseline Firm Importer Dummy at Baseline	0.105***	(0.001)
Observations	3,641,121	
R-squared	0.113	
Firm FE	No	
Worker FE	No	
Year FE	Yes	
2-digit industry FE	No	
Region FE	No	
2-digit industry X Year FE	Yes	
Region X Year FE	Yes	

Table 12: Estimated Impacts of GFC-induced Demand Shock on Worker's Employment Probability

Note: This table displays the regression outcomes resulting from estimating equation (2) by fixed effect estimation. The sample includes all workers in firms shocked in 2008, excluding workers in firms from the agricultural and related sectors, workers aged below 26 or above 49 in 2008, and foreigners. The dependent variable in this regression was computed by assigning a value of zero to a worker absent from the panel in a given year and one in case that worker was present in the panel. Robust standard errors are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** designates a variable significant at the 5% significance level, and * designates a variable significant at the 10% significance level. To run these regressions we had to balance our panel. No trimming was performed on the outcome variable, as it would make little sense in this case.

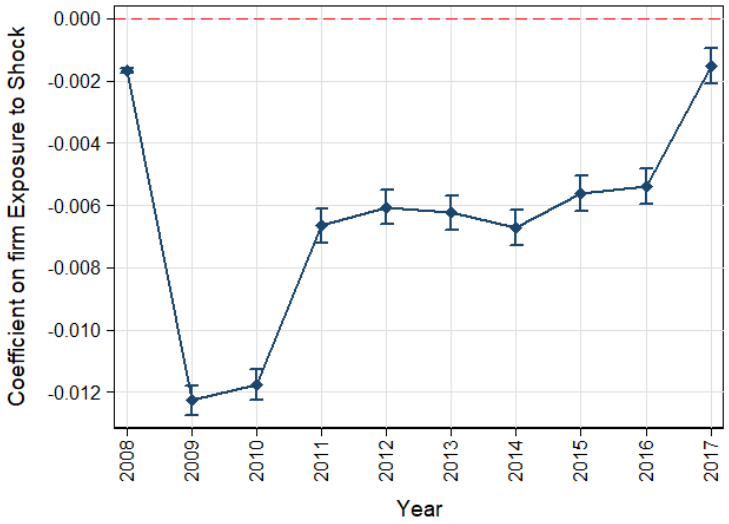

Figure A: Exposure of Workers in term of Employment to 2008 Shock.

Note: This figure presents the effects of firms' commercial partners' income contraction on employment probability, from 2008 to 2017, for workers working in those firms in 2008. Each point corresponds to a given $\widehat{\beta_t}$ in the respective year coming out of estimating equation (2) by fixed effects estimation. 95% confidence intervals based on robust standard errors are also displayed. The sample includes workers from shocked firms in 2008 that meet our sampling criteria, excluding firms from the agricultural and related sectors. To run this regression we had to balance our worker level panel. The dependent variable in this regression was computed by assigning a value of zero to a worker non-present in the panel in a given year and one in case that worker was present in the panel.

	(1)	
	Export Concentration	Std. Deviation
β_{2008}	-0.059***	(0.001)
β_{2009}	-0.042***	(0.001)
β_{2010}	-0.035***	(0.001)
β_{2011}	-0.032***	(0.001)
β_{2012}	-0.031***	(0.001)
β_{2013}	-0.026***	(0.001)
β_{2014}	-0.022***	(0.001)
β_{2015}	-0.020***	(0.001)
β_{2016}	-0.021***	(0.001)
β_{2017}	-0.019***	(0.001)
Imports at Baseline	-0.166***	(0.006)
Firm Size at Baseline	-0.000	(0.000)
Av. Employment Growth 2004-2007	-0.001	(0.006)
Av. LHS Variable Growth 2004-2007	-0.388***	(0.016)
Av. Wage Bill Growth 2004-2007	0.001	(0.005)
Observations	108,176	
R-squared	0.164	
Firm FE	No	
Year FE	No	
2-digit industry FE	No	
Region FE	No	
2-digit industry X Year FE	Yes	
Region X Year FE	Yes	

Figure 13: Estimated Impact of 2008 Shock on Export Diversification

Note: This table displays the regression outcomes resulting from estimating equation (1) by fixed effect estimation for the computed export diversification measure (an adaptation to exports of the Herfindahl-Hirschman Index). The sample includes all firms shocked in 2008 that meet our exclusion criteria, excluding firms from the agricultural and related sectors. Clustered robust standard errors (clustered at the firm level) are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** designates a variable significant at the 5% significance level, and * designates a variable significant at the 10% significance level. Outcomes were trimmed at the upper 5% and lower 5%. These effects capture only the effects for firms alive until year *t*.

10. Appendix II

Export Context Figure B below identifies by descending order Portuguese firms' main 2008 commercial partners in terms of export destination and evaluates how intense was the 2008 deceleration of GDP growth for these economies. Growth deceleration is measured by taking the percentage point difference between partner countries growth rates in 2008-2007 relative to those of 2007-2006. In line with the predictions of the gravity equation of trade (Tinbergen (1962)), Portuguese firms' larger export destinations are mainly nearby European countries (like Spain, or Germany), or large economies (as the US).

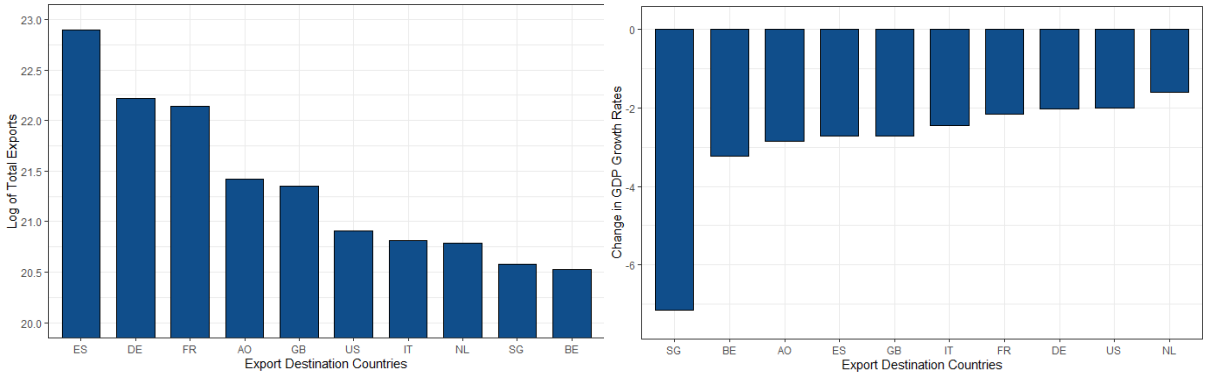

Figure B: Log of Exports (left) and GDP growth deceleration (right) for Ten Largest Export Destination Countries, for Portugal, in 2008.

Note: This figure displays the log of total exports for the ten largest export destination partner countries of Portuguese firms, in 2008 (left) and the percentage point change in growth rates from 2006-2007 to 2007-2008 for the 2008 ten largest export destination countries of Portuguese firms (right). We confine our sample of firms to firms with a non-missing shock value for 2008. The country labels are defined as follows: ES stands for Spain, DE for Germany, FR for France, AO for Angola, GB for the United Kingdom, US for the United States of America, IT for Italy, NL for the Netherlands, SG for Singapore, and BE for Belgium. Data: *Comércio Internacional*, *Sistema de Contas Integradas das Empresas* (SCIE), WB data.

Trade Adjustment Margins This subsection of the appendix follows the growth decomposition of Gopinath and Neiman (2014) to study what share of export growth from 2004 to 2017 is explained by firm exits and firm entering the export status ("*extensive*" margin) and what share is explained by the export behavior of firms *already* existing as exporters ("*intensive*" margin). This exercise broadens the scope and considers a sample populated by every exporting firm in the Portuguese economy at any given point in time between 2004 and 2017. Firms with meaningless unique firm identifiers are dropped. Applying this decomposition to the narrow sample only containing shocked firms would lead to biases arising from sample construction: for example, to be present in the previous sample, a firm had to be shocked in 2008, meaning that no firm exits would have been accounted for in 2008. Export growth is decomposed according to

$$\frac{\Delta \upsilon_t}{\upsilon_{t-1}} = \frac{\upsilon_t - \upsilon_{t-1}}{\upsilon_{t-1}} = \underbrace{\sum_{i \in \Psi_{t-1} \cap \Psi_t} \frac{\upsilon_{it} - \upsilon_{it-1}}{\upsilon_{t-1}}}_{Intensive\ Adjustment\ Margin} + \underbrace{\sum_{i \in \Psi_t, i \notin \Psi_{t-1}} \frac{\upsilon_{it}}{\upsilon_{t-1}} - \sum_{i \in \Psi_{t-1}, i \notin \Psi_t} \frac{\upsilon_{it-1}}{\upsilon_{t-1}}}_{Extensive\ Adjustment\ Margin}$$

Where the set Ψ_t includes all existing exporting firm in period t. $\upsilon_t = \sum_{i \in \Psi_t} \upsilon_{it}$, stands for the total value of exports in the sample in period t. υ_{it} in turn represents the sum of exports of firm i in period t. The left-hand side of this equation denotes the yearly growth rate of firm exports in the economy from one period to the next. The first term of the right-hand side stands for the share of $\frac{\Delta \upsilon_t}{\upsilon_{t-1}}$ explained by exports *of firms existing in both* t *and* $t-1$. The right-hand side of

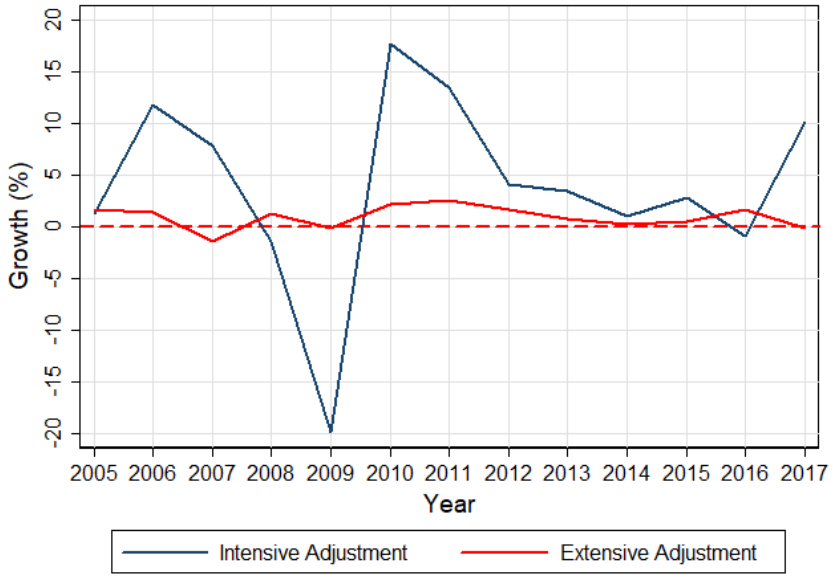

Figure C: Decomposition of Export Growth: Extensive and Intensive margin

Note: This figure displays the share of export growth of Portuguese firms accounted by export growth by incumbent firms (blue line) and the share of export growth accounted for by exiting and newborn firms (red line). By construction, the vertical sum of both schedules yields at a given point in time, total export growth. Data sources: own computations using *Comércio Internacional*.

the equation denotes the share of export growth accounted for by exiting and entering firms: the contribution to export growth from new firms discounted by the contribution of leaving incumbents. The obtained trajectory is displayed in Figure C. In this figure, at any given point in time, the sum of the red and blue values correspond to total export growth. Consistent with the findings of Gopinath and Neiman (2014) for Argentinian imports, this thesis finds that firm

exits and births account for a relatively insignificant share of export growth, relative to incumbent firms. Table 13 below displays the complete results.

Year	Total Export Growth (%)	Export Growth (Intensive) (%)	Exports Growth (Extensive) (%)
2005	2.943384	1.314635	1.628749
2006	13.29897	11.8421	1.456866
2007	6.501647	7.852502	-1.350856
2008	-0.0426158	-1.340833	1.298217
2009	-19.91084	-19.81623	-0.0946164
2010	19.93273	17.73329	2.199444
2011	16.14658	13.53125	2.615333
2012	5.833121	4.163299	1.669822
2013	4.210696	3.440509	0.7701874
2014	1.281334	0.9934343	0.2878994
2015	3.318195	2.810781	0.5074142
2016	0.7753475	-0.8464767	1.621824
2017	9.974228	10.13513	-0.160905

Table 14: Export Growth Decomposition

Note: This table displays the results of estimating equation (2) above with a sample including all exporting firms in *Comércio Internacional*, except firms with meaningless unique firm identifiers (missing values, or values with too few digits). By mathematical construction, the first column is equal to the sum of the remaining columns. Intensive margin is to be understood as capturing the responses of incumbent firms, and the extensive one as capturing the contribution of those entering and leaving the panel.

Decomposing Employment Variation Applying the same decomposition described above for total employment variation instead of total export variation yields insights on the share of the variation of employment explained by incumbent firms ("intensive margin") and by the entry or exiting of firms ("extensive margin"). The obtained results are presented in Figure D below. The sample considered for this exercise includes all firms meeting the criteria stated in Section 3 on sampling. One immediately notices the sharp decline in employment in 2009. Strikingly, most of this variation is explained by the exiting (and entering) of firms (red line). Another interesting pattern relates to the presence of negative total employment growth in the post-crisis period, contrasting with a period of positive employment growth prior to the financial crisis.

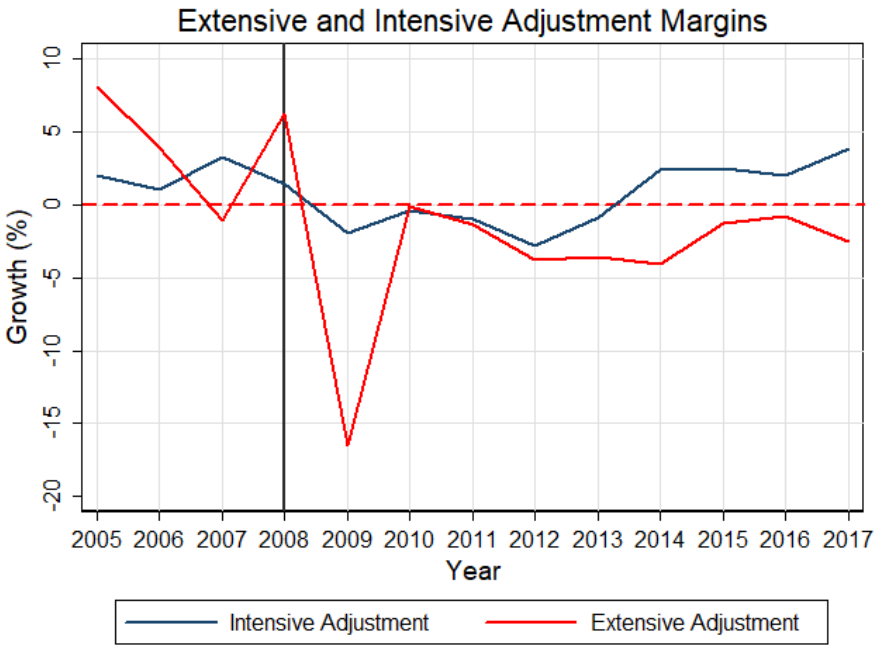

Figure D: Decomposition of Employment Growth: Extensive and Intensive margin

Note: This figure displays the share of employment growth of Portuguese firms accounted by employment growth by incumbent firms (blue line) and the share of employment growth accounted for by exiting and newborn firms (red line). By construction, the vertical sum of both schedules yields at a given point in time, total employment growth. Data sources: own computations using *Comércio Internacional, SCIE and Quadros de Pessoal*.

Size and Export Decline Still following Gopinath and Neiman (2014) this thesis further investigate whether there are size heterogeneities in the pattern of export adjustments, it does so via a binned scatter plot and via two simple linear regressions. It uses exports at baseline (2007) and divides the universe of exporting firms alive in 2007, 2008, and 2009, into 100 equally sized bins corresponding to the centiles of the distribution of exports. For each of these bins one then compute the average growth rate of the average export growth for firms from 2007 to 2009. As also done in Gopinath et al. (2014) for the case of imports, this exercise omits from this sample those small firms that exhibited a growth of exports superior to 100%. Results are displayed in Figure E below. The observed trajectory indicates that larger firms at baseline had higher magnitude declines in exports. To test this more rigorously, one runs by OLS with robust standard errors

$$\hat{x}_{j2007-2009} = \beta_o + \beta_1 \ln(x_{j2007}) + \beta_2 sector_j + \epsilon_{jt} \ (i)$$

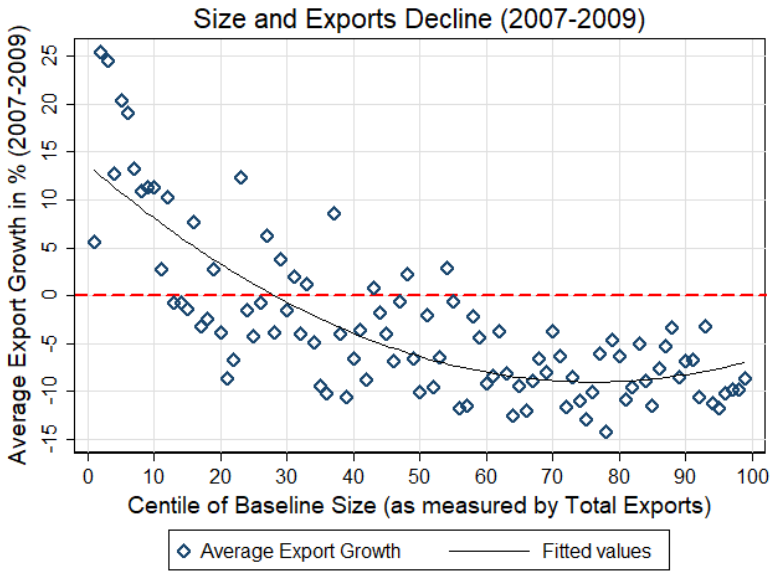

Figure E: Size and Exports Decline (2007-2009)

Note: To plot this figure we use exports at baseline (2007) and divide the universe of exporting firms alive in 2007, 2008, and 2009, into 100 equally sized bins corresponding to the centiles of the exports distribution. For each of these bins we compute the average growth rate of the average export growth for firms from 2007 to 2009. We also display a quadratic regression in black. In this scatter, firms that exhibited a growth of exports superior to 100% were disregarded.

where $\hat{x}_{j2007-2009}$ is the average growth rate of exports for firm j between 2007 and 2009. $ln(x_{j2007})$ stands for the log of initial exports and $sector_j$ has the same meaning as in Section 3, and ϵ_{jt} is a zero mean disturbance term. The regression results are displayed in Table 14 below. The coefficients are negative and significant, corroborating the finding aforementioned.

	(1)	(2)
	Av. Export Growth (2007-2009)	Av. Export Growth (2007-2009)
Initial Exports (2007, in logs)	-2.813***	-2.958***
	(0.096)	(0.124)
Sectors		-0.162***
		(0.044)
Constant	32.849***	37.518***
	(1.331)	(1.940)
Observations	25,311	19,415
R-squared	0.033	0.032

Table 15: Regression of Export Growth on Firm Size

Note: These outcomes result from estimating equation (*i*) above by OLS with robust standard errors (in parenthesis). The three *** denote significance at the 1% level. The lower number of observations when controlling for sectors is explained by the inability of assigning a sector as defined in Section 3 to some firm in our trade data set.

11. Appendix III

This appendix provides some additional algebraic detail to the model developed in Section 2.

Optimal Solution for Labor To find the optimal solution for labor for firms in stage one, and to show that a maximum (rather than a minimum) was found:

$$Max_{\{L^u_{jt}\}} \Pi_{jt} = p_{jt}A_{jt}L^{u\,1-\alpha}_{jt}\overline{L^s_{jt}}^{\beta} - w_t L^u_{jt} - \phi_{jt} - [r_{jt-1} + (1-\gamma(A_{jt})\theta]b_{jt-1} \quad \forall_{t,j}$$

$$\frac{\partial \Pi_{jt}}{\partial L^u_{jt}} = 0 \Leftrightarrow (1-\alpha)p_{jt}A_{jt}L^{u\,-\alpha}_{jt}\overline{L^s_{jt}}^{\beta} = w_t \Leftrightarrow L^{u*}_{jt} = \left(\frac{p_{jt}\,\overline{L^s_{jt}}^{\beta}(1-\alpha)A_{jt}}{w_t}\right)^{1/\alpha}$$

$$\frac{\partial^2 \Pi_{jt}}{\partial {L^u_{jt}}^2} = -\alpha(1-\alpha)p_{jt}A_{jt}L^{u\,-(1+\alpha)}_{jt}\overline{L^s_{jt}}^{\beta} < 0$$

Since $\alpha \in (0;1)$, the second order derivative is negative. This implies that the objective function is concave and that L^{u*}_{jt} maximizes the function.

Price Elasticities To show that elasticities of wage bill, employment, ratio of unskilled to skilled and revenues with respect to price are constant and equal across themselves we take in turn:

$$\epsilon_{L^{u*}_{jt};p_{jt}} = \frac{\partial L^{u*}_{jt}}{\partial p_{jt}} \times \frac{p_{jt}}{L^{u*}_{jt}} = \frac{1}{\alpha}\left(\frac{p_{jt}\,\overline{L^s_{jt}}^{\beta}(1-\alpha)A_{jt}}{w_t}\right)^{\frac{1-\alpha}{\alpha}} \times \left(\frac{\overline{L^s_{jt}}^{\beta}(1-\alpha)A_{jt}p_{jt}}{w_t}\right)^{\frac{\alpha-1}{\alpha}} = \frac{1}{\alpha}$$

$$\epsilon_{w_t L^{u*}_{jt};p_{jt}} = \frac{\partial w_t L^{u*}_{jt}}{\partial p_{jt}} \times \frac{p_{jt}}{w_t L^{u*}_{jt}} = \frac{w_t}{\alpha}\left(\frac{p_{jt}\,\overline{L^s_{jt}}^{\beta}(1-\alpha)A_{jt}}{w_t}\right)^{\frac{1-\alpha}{\alpha}} \times \left(\frac{\overline{L^s_{jt}}^{\beta}(1-\alpha)A_{jt}p_{jt}}{w_t}\right)^{\frac{\alpha-1}{\alpha}} = \frac{1}{\alpha}$$

$$\epsilon_{R^*_{jt};p_{jt}} = \frac{\partial p_{jt}A_{jt}L^{u\,1-\alpha}_{jt}\overline{L^s_{jt}}^{\beta}}{\partial p_{jt}} \times \frac{p_{jt}}{R^*_{jt}} = \frac{\partial p_{jt}A_{jt}\left(\frac{p_{jt}\,\overline{L^s_{jt}}^{\beta}(1-\alpha)A_{jt}}{w_t}\right)^{\frac{1-\alpha}{\alpha}}\overline{L^s_{jt}}^{\beta}}{\partial p_{jt}} \times \frac{p_{jt}}{R^*_{jt}} = \frac{1}{\alpha}$$

$$\epsilon_{\frac{L^{u*}_{jt}}{L^s_{jt}};p_{jt}} = \frac{\partial L^{u*}_{jt}/L^{s*}_{jt}}{\partial p_{jt}} \times \frac{p_{jt}}{L^{u*}_{jt}/L^{s*}_{jt}} = \frac{1}{L^{s*}_{jt}}\frac{1}{\alpha}\left(\frac{p_{jt}\,\overline{L^s_{jt}}^{\beta}(1-\alpha)A_{jt}}{w_t}\right)^{\frac{1}{\alpha}}\frac{L^{s*}_{jt}}{L^{u*}_{jt}} = \frac{1}{\alpha}$$

Investment Decision At the end of stage two, firms decide investment implicitly setting the marginal return of investment equal to the marginal cost of investment

$$\frac{\partial \mathbb{E}[\Pi_{jt+1}]}{\partial i_{jt}} = 0 \Leftrightarrow \frac{\partial \mathbb{E}[p_{jt+1}A_{jt+1}(\overset{+}{\widehat{i_{jt}}})L^{u\,1-\alpha}_{jt+1}\overline{L^s_{Jt+1}}^{\beta} - w_{t+1}L^u_{jt+1} - \left[r_{jt} + (1-\gamma(A_{jt}))\theta\right]b_{jt}(\overset{+}{\widehat{i_{jt}}})]}{\partial i_{jt}} = 0$$

$$\frac{\partial \mathbb{E}[\Pi_{jt+1}]}{\partial i_{jt}} = 0 \Leftrightarrow \overline{L^s_{jt+1}}^{\beta} \frac{\partial \mathbb{E}[p_{jt+1} A_{jt+1} \left(\overset{+}{\widetilde{i_{jt}}}\right) L^{u\,1-\alpha}_{jt+1}]}{\partial i_{jt}} = \frac{\partial \mathbb{E}[w_{t+1} L^u_{jt+1} + \left[r_{jt} + (1-\gamma(A_{jt}))\theta\right] b_{jt}(\overset{+}{\widetilde{i_{jt}}})]}{\partial i_{jt}}$$

Where we have not included fixed costs knowingly, as they are irrelevant for the first order condition: they are constant and perfectly foreseen. The marginal returns of investment arise due to higher idiosyncratic productivity tomorrow, while the marginal costs of investment arises due to the need of financing such investment with debt.

Market reallocation Firms will prefer to reallocate the share $\rho(d_{m^*})$ of production if the following condition is met

$$\rho(d^*_m)\sigma_{jt} A_{jt} L^{u\,1-\alpha}_{jt} \overline{L^s_{jt}}^{\beta} - k(d_{m^*}) > \rho(d_{m^*}) p_{jt} A_{jt} L^{u\,1-\alpha}_{jt} \overline{L^s_{jt}}^{\beta} \Leftrightarrow$$

$$\rho(d_{m^*})\sigma_{jt} A_{jt} \left(\frac{p_{jt}\,\overline{L^s_{jt}}^{\beta}(1-\alpha)A_{jt}}{w_t}\right)^{\frac{1-\alpha}{\alpha}} \overline{L^s_{jt}}^{\beta} - k(d_{m^*}) > \rho(d_{m^*}) p_{jt} A_{jt} \left(\frac{p_{jt}\,\overline{L^s_{jt}}^{\beta}(1-\alpha)A_{jt}}{w_t}\right)^{\frac{1-\alpha}{\alpha}} \overline{L^s_{jt}}^{\beta} \Leftrightarrow$$

$$\rho(d_{m^*})\sigma_{jt} A^{1/\alpha}_{jt} p_{jt}^{\frac{1-\alpha}{\alpha}} \left(\frac{(1-\alpha)}{w_t}\right)^{\frac{1-\alpha}{\alpha}} \overline{L^{s\,\frac{\beta}{\alpha}}_{jt}} - k(d_{m^*}) > \rho(d_{m^*}) p_{jt}^{\frac{1}{\alpha}} A^{\frac{1}{\alpha}}_{jt} \left(\frac{(1-\alpha)}{w_t}\right)^{\frac{1-\alpha}{\alpha}} \overline{L^{s\,\frac{\beta}{\alpha}}_{jt}} \Leftrightarrow$$

$$\rho(d_{m^*})\sigma_{jt} A^{1/\alpha}_{jt} p_{jt}^{\frac{1-\alpha}{\alpha}} \left(\frac{(1-\alpha)}{w_t}\right)^{\frac{1-\alpha}{\alpha}} \overline{L^{s\,\frac{\beta}{\alpha}}_{jt}} - k(d_{m^*}) > \rho(d_{m^*}) p_{jt}^{\frac{1}{\alpha}} A^{\frac{1}{\alpha}}_{jt} \left(\frac{(1-\alpha)}{w_t}\right)^{\frac{1-\alpha}{\alpha}} \overline{L^{s\,\frac{\beta}{\alpha}}_{jt}} \Leftrightarrow$$

$$\rho(d_{m^*})\sigma_{jt} p_{jt}^{\frac{1-\alpha}{\alpha}} - \frac{k(d_{m^*})}{A^{\frac{1}{\alpha}}_{jt} \left(\frac{(1-\alpha)}{w_t}\right)^{\frac{1-\alpha}{\alpha}} \overline{L^{s\,\frac{\beta}{\alpha}}_{jt}}} > \rho(d_{m^*}) p_{jt}^{\frac{1}{\alpha}} \Leftrightarrow$$

Calling

$$A^{\frac{1}{\alpha}}_{jt} \left(\frac{(1-\alpha)}{w_t}\right)^{\frac{1-\alpha}{\alpha}} \overline{L^{s\,\frac{\beta}{\alpha}}_{jt}} = f(A_{jt}, w_t, L^s_{jt})$$

$$\rho(d_{m^*})\sigma_{jt} p_{jt}^{\frac{1-\alpha}{\alpha}} - \frac{k(d_{m^*})}{f(A_{jt}, w_t, L^s_{jt})} > \rho(d_{m^*}) p_{jt}^{\frac{1}{\alpha}} \Leftrightarrow$$

$$\sigma_{jt} p_{jt}^{\frac{1}{\alpha}} p_{jt}^{-1} - p_{jt}^{\frac{1}{\alpha}} > \frac{k(d_{m^*})}{\rho(d_{m^*}) f(A_{jt}, w_t, L^s_{jt})}$$

12. Appendix IV

Worker Earnings, Hours Worked and Scarring Effects This appendix shows how workers working in firms harder hit by GFC-induced demand shock were worse off in terms of average earnings and average hours worked, relatively to their otherwise similar peers working in mildly hit firms, at the time of the shock. Table 15 below presents descriptive statistics for the worker-level panel. The panel contains 3,641,121 observations for the post-shock period.

	2004-2007		2008-2017	
	Mean	Std. Dev.	Mean	Std. Dev.
Worker outcomes				
Real monthly wages (log)	6.6	1.8	4.5	3.5
Hours worked per month (log)	4.8	1.3	3.3	2.5
Average Hours Worked (cumulative)			0.8	0.4
Average Real wages (cumulative)			0.9	0.7
Controls (pre-shock period)				
Age	35.3	6.6		
Men	60%	49%		
Post-High School Education	13%	33%		
Firm level shock				
Av. Shock (in %)	-2.4	3.4	-1.3	2.3
Total number of worker-year observations	1177173		3641121	

Table 16: Descriptive Statistics for the Worker-Level Panel, by period.

Note: These descriptive Statistics were computed using data from *Quadros de Pessoal*, SCIE, World Bank Data, and trade data from *Comércio Internacional*. The sample of individuals includes workers aged between 26 and 49 as of 2008 that worked in shocked firms as of 2008, excluding foreign individuals and individuals working in firms from the agricultural, mining or fishing sectors. The shock measure considered consists of the negative of a weighted average of baseline export destination Portuguese firms' partners growth rates.

The econometric model employed is equation (2) presented in Section 5. For convenience, the model is

$$\omega_{ijt} = \sum_{t=1}^{T} \beta_t . shock_{j2008} D_t + \boldsymbol{\gamma X}_{j2007} + \boldsymbol{\Gamma X}_{i2007} + \nu^{rt} + \iota^{st} + \delta_t + \epsilon_{ijt} \ (ii)$$

Where ω_{tji} is discussed below. The firm-level vector $\boldsymbol{X}_{j2007}$ includes the same variables described earlier. $\boldsymbol{X}_{i2007}$ is a worker-level vector including age at baseline, age squared at baseline, a dummy for higher education at baseline, and gender at baseline. ν^{rt}, ι^{st}, and δ_t have the same meaning as before. To perform this exercise, the sample was confined to non-foreign individuals working in a shocked firm as of 2008, aged between 26 and 49 as of 2008 (to prevent

them from being artificially unemployed through schooling or retirement). The coefficient β_t in this case captures the differentiated effect on employment probability of the 2008 GFC-induced demand contraction for observationally equal workers working in mildly versus hard hit firms at the time of the shock. In this setting, as in Yagan (2019), the identification assumption is that individuals are seen as randomly assigned to companies given their baseline controls. Following Fernandes and Silva (2020), this section's measure of average wages and average hours is computed as

$$\omega_{ijt} = \frac{\frac{1}{T-2007}\sum_{t=2008}^{T} y_{ijt}}{\frac{1}{4}\sum_{s=2004}^{2007} y_{ijs}} = \frac{\frac{1}{T-2007}\sum_{t=2008}^{T} y_{ijt}}{\overline{y_{IJ}^{04-07}}}$$

Where y_{ijt} is the real wage (computed as described in Section 4) of worker i working in firm j in a given year t, or the number of hours worked by the worker in that year, depending on the specification. If a worker is absent from the panel in a given period, $y_{ijt} = 0$. This measure captures the average cumulative earnings (or hours) of workers until year T as a multiple of their pre-shock average wage (hours worked). Relative to taking logs of the dependent variable, this approach has the advantage of avoiding taking logs of variables having values equal to zero, and accounting for initial heterogeneity in wages across workers.

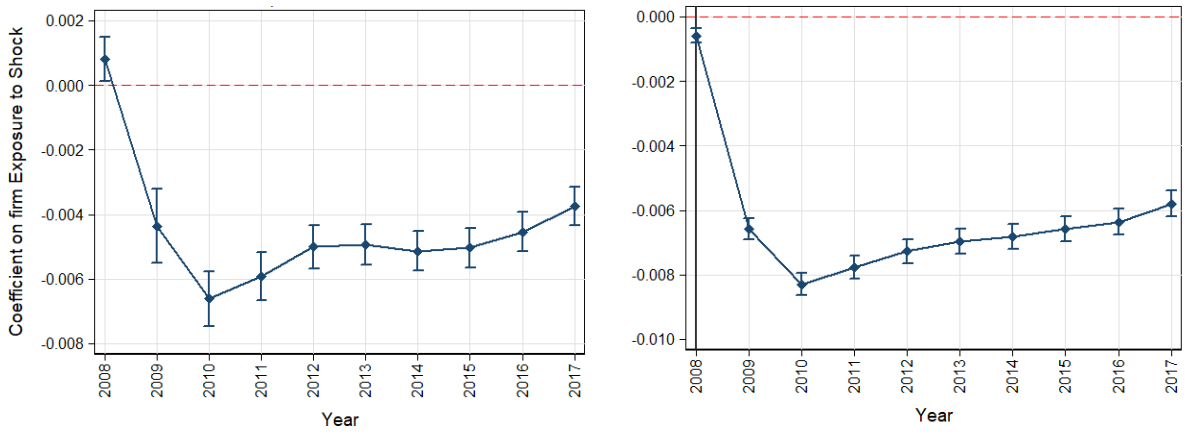

Figure F: Exposure of Workers in term of Cumulative Normalized Average Wages (left) and Cumulative Normalized Average Hours (right) to 2008 Shock.

Note: This figure presents the effects of firms' commercial partners' income contraction on: average wages as a multiple of pre-shock average wages (left) and average hours as a multiple of pre-shock average hours (right), from 2008 to 2017, for workers working in those firms in 2008. Each point corresponds to a given $\widehat{\beta_t}$ in the respective year coming out of estimating equation (*ii*) by fixed effects estimation. 95% confidence intervals based on robust standard errors are also displayed. The sample includes workers from shocked firms in 2008 that meet our sampling criteria, excluding firms from the agricultural and related sectors. To run this regression we had to balance our worker level panel. Observations: 3,641,121.

One would expect negative coefficients $\hat{\beta}_t$'s: workers initially working in hardly firms are expected to be more affected on earnings (or hours) than their otherwise similar peers working in mildly hit firms, on average and everything else constant. Figure F and Table 16 display the obtained regression results. The negative coefficients found suggest that the GFC-demand induced shock struck workers in a persistent manner. These results are inconsistent with costless worker-level adjustments to shocks.

	(1)		(1)	
	Earnings	Std. Deviation	Hours	Std. Deviation
β_{2008}	0.001**	(0.000)	-0.001***	(0.000)
β_{2009}	-0.004***	(0.001)	-0.007***	(0.001)
β_{2010}	-0.007***	(0.000)	-0.008***	(0.000)
β_{2011}	-0.006***	(0.000)	-0.008***	(0.000)
β_{2012}	-0.005***	(0.000)	-0.007***	(0.000)
β_{2013}	-0.005***	(0.000)	-0.007***	(0.000)
β_{2014}	-0.005***	(0.000)	-0.007***	(0.000)
β_{2015}	-0.005***	(0.000)	-0.007***	(0.000)
β_{2016}	-0.005***	(0.000)	-0.006***	(0.000)
β_{2017}	-0.004***	(0.000)	-0.006***	(0.000)
Baseline Age of Worker	0.003***	(0.001)	0.018***	(0.001)
Baseline Squared Age of Worker	-0.000***	(0.000)	-0.000***	(0.000)
Baseline Gender of Worker	0.031***	(0.001)	0.026***	(0.000)
Dummy for higher education at baseline	0.084***	(0.001)	0.022***	(0.001)
Av. Employment Growth 2004-2007 (Firm-level)	-0.000***	(0.000)	0.000***	(0.000)
Av. Wage Bill Growth 2004-2007 (Firm-level)	0.000***	(0.000)	-0.000***	(0.000)
Worker's Baseline Firm Size at Baseline	-0.000***	(0.000)	-0.000***	(0.000)
Worker's Baseline Firm Importer Dummy at Baseline	0.079***	(0.001)	0.086***	(0.001)
Observations	3,641,121		3,641,121	
R-squared	0.041		0.1436	
Firm FE	No		No	
Worker FE	No		No	
Year FE	Yes		Yes	
2-digit Industry FE	No		No	
Region FE	No		No	
2-digit industry X Year FE	Yes		Yes	
Region X Year FE	Yes		Yes	

Table 17: Estimated Impacts of GFC-induced Demand Shock on Worker's Cumulative Average Earnings as Multiples of Pre-Shock Average and Cumulative Average Hours as Multiples of Pre-Shock Average.

Note: This table displays the regression outcomes resulting from estimating equation (*ii*) by fixed effect estimation. The sample includes all workers in firms shocked in 2008, excluding workers in firms from the agricultural and related sectors, workers aged below 26 or above 49 in 2008, and foreigners. The dependent variable in this regression is the Cumulative Average Earnings as Multiples of Pre-Shock Average (left) and the analogous for hours worked (right). Robust standard errors are displayed in parentheses. *** designates a variable significant at the 1% significance level, ** designates a variable significant at the 5% significance level, and * designates a variable significant at the 10% significance level. To run these regressions we had to balance our panel. No trimming was performed on the outcome variable.