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Author: Pinar Uysal

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Boston College

The Graduate School of Arts and Sciences

Department of Economics

ESSAYS IN MACROECONOMICS

a dissertation

by

PINAR UYSAL

submitted in partial fulfillment of the requirements

for degree of

Doctor of Philosophy

August 2009

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ESSAYS IN MACROECONOMICS

by

PINAR UYSAL

Advised by

FABIO GHIRONI (chair)

PETER IRELAND CHRISTOPHER F. BAUM

Abstract

Chapter 1: Foreign Direct Investment and Contract Enforcement

Many developing countries are financially constrained and therefore have to rely on international capital flows to finance economic activity. Empirical evidence shows that Foreign Direct Investment (FDI) as a percentage of total capital flows is higher for less developed countries compared to more developed countries. This chapteruses a dynamic contracting model with human capital to explain why less developed countries receive a greater percentage of capital flows as FDI. I analytically show that countries that are financially constrained have a higher share of FDI in total capital flows, and that the share of FDI in total capital flows is increasing in human capital flows. In addition, the positive association between the share of FDI in total capital flows and human capital flows is decreasing in the degree of financial constraints. I construct a measure of intangible assets of FDI and find empirical support for the analytical results.

Chapter 2: Trade Liberalization, Firm Heterogeneity, and Unemployment: An Em-

pirical Investigation

This chapter is a joint work with Yoto V. Yotov. We provide empirical evidence for the interaction between firm-level total factor productivity and trade liberalization as key determinants of firm-level job destruction caused by trade. Employing US firm-level data, we find strong empirical support for the following: a) All else equal, a one percent increase in total factor firm productivity decreases trade-induced layoffs by 32%; b) An additional percent of trade liberalization increases the number of firm-level trade-induced layoffs by 2%; c) Trade liberalization results in an increase in the minimum level of productivity required for domestic production; d) Trade liberalization lowers the minimum productivity threshold required for exporting; e) The increase due to trade liberalization in the minimum productivity threshold for domestic production is larger than the absolute decrease in the export productivity threshold.

Chapter 3: Do Audit Fees Influence Credit Risk and Asymmetric Information Problems? Evidence from the Syndicated Loan Market

This chapter is a joint work with Lewis W. Gaul. We examine whether an increase in the demand for auditing services is associated with a decrease in borrowers' credit risk and asymmetric information problems in the syndicated loan market. In the syndicated loan market, potential accounting errors exacerbate credit risk and asymmetric information problems. The purpose of financial statement audits is to provide reasonable assurance that accounting records are free from material errors. We hypothesize that if auditees face an upward sloping supply curve for auditing services, an increase in the demand for auditing services increases both the equilibrium price and quantity of auditing services purchased. We interpret the equilibrium quantity of auditing services as the number of auditing hours billed and the price of auditing services as the hourly fee. We assert that an increase in the quantity of auditing services purchased reduces the likelihood of an accounting error because auditors exert more effort verifying the accuracy of accounting records. We present empirical evidence that a demand-induced increase in audit fees is associated with syndicated loans with lower interest rate spreads and shorter maturity lengths, which we interpret as evidence consistent with the assertion that these audit fee increases reduce credit-risk and asymmetric information problems. We empirically identify an increase in the demand for auditing services with instrumental variables that are intended to capture shifts in the demand curve for auditing services, rather than shifts in the supply curve for auditing services. In addition, we find that audit fees are positively associated with the number of lenders in loan syndicates, but are unable to attribute this association to an increase in the demand for auditing services.

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Foreign Direct Investment and Contract Enforcement

Doctoral Dissertation Chapter 1

Pinar Uysal

Department of Economics

Boston College

Chestnut Hill, MA

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I am indebted to Fabio Ghironi, Gokce Uysal Kolasin, and Lewis Gaul for comments, suggestions, and encouragement. I am also grateful to Peter Ireland, Christopher Baum, Yoto V. Yotov, Marissa Ginn, and Tatiana Mihailovschi-Muntean for thoughtful suggestions and comments on my work.

1 Introduction

Many developing countries are financially constrained, and therefore have to rely on international capital flows to finance economic activity.[1] Empirical evidence shows that Foreign Direct Investment (FDI) as a percentage of total capital flows is higher for less developed countries compared to more developed countries.[2] This paper uses a dynamic contracting model with human capital to explain why less developed countries receive a greater percentage of capital flows as FDI. I show that countries that are financially constrained have a higher share of FDI in total capital flows, and that the share of FDI in total capital flows is increasing in human capital flows. In addition, the positive association between the share of FDI in total capital flows and human capital flows is decreasing in the degree of financial constraints.

In my model, international contracts are not perfectly enforceable, and when an international investor makes an investment in a host country, it faces the risk that the investment might be confiscated. The host country may gain from confiscating the output in the short run; however, it may be unable to attract future foreign investments as a consequence. Hence, any contract between the international investor and the host country must be self enforcing, which implies that countries should not have incentives to renege upon the contract.

The main assumption of the model is that FDI is inalienable from human capital investment, which means that foreign investors provide the host country with intangible assets necessary to realize the full benefits of FDI. For example, these intangible assets may include managerial and entrepreneurial skills, and engineering experience. The physical and human capital aspects of FDI differ simply because, in case of a default, physical capital can be confiscated by the host country while intangible human capital assets cannot be confiscated. If the host country decides to expropriate FDI flows, then the inalienable assets

[1] These capital flows can be divided into two main groups: Foreign Direct Investment (FDI) and non-FDI, where non-FDI corresponds to foreign portfolio flows.

[2] See (Hausmann and Fernandez-Arias 2000) and (Albuquerque 2003).

are no longer available. Therefore, when the host country considers confiscating foreign capital, it weighs the benefits and costs. The benefit of confiscating physical capital flows is gaining ownership of all investment returns, while the cost is that all subsequent investment returns are lower because human capital cannot be confiscated, and the host country loses all future foreign capital investments. As a consequence, from a host country's point of view, it would not be as advantageous to expropriate FDI compared to other types of capital flows given that human capital is lost when FDI is expropriated.

In the limited commitment environment of my model, I analytically show that when a host country is financially constrained, the expected loss for the international investor on FDI flows is lower than the expected loss on non-FDI flows due to the intangible part of FDI. Hence, the international investor finds it optimal to invest a greater share of FDI flows in total capital flows to financially constrained countries, and there is a positive association between human capital flows and FDI share. In addition, the positive association between the share of FDI in total capital flows and human capital flows is decreasing in the degree of financial constraints.

To test the analytical predictions of the model empirically, I construct a measure of intangible assets of FDI following (Coe and Helpman 1995) . Using an unbalanced panel dataset, I find strong empirical support for the following propositions: a) The more a country is financially constrained, the higher the share of FDI in total capital flows; b) There is a positive relation between human capital flows and the share of FDI flows; c) As the degree of financing constraints decrease, the positive association between human capital and FDI becomes weaker.

I concentrate on the capital flows from developed countries to developing countries because the impact of capital flows on economies is not uniform across different levels of development. (Blonigen and Wang 2005) show that the FDI experiences of less developed countries are systematically different from those of developed countries, and pooling rich and poor countries in analysis leads to incorrect inferences about the effect of FDI on growth and domestic investment.

My paper contributes to the theoretical literature on FDI by combining a model of FDI with human capital in a dynamic contracting model. It is important to examine FDI flows in a dynamic environment to reflect international investors' long lasting interest.[3] In a static setting, (Eaton and Gersovitz 1984) analyzed the level of FDI under the risk of expropriation and found that the threat of expropriation lowers the welfare of the host country. (Thomas and Worrall 1994) analyzed the size of FDI flows in a dynamic setting in which investors and host countries engage in self enforcing contracts. They found that there is under-investment at the beginning of a contract, but investment increases over time and reaches the efficient level. (Albuquerque 2003) extends Thomas and Worrall's (1994) framework to allow for FDI and non-FDI flows and utilizes the idea that the presence of intangible assets would limit the host country's incentives to expropriate the investment.

My paper contributes to the empirical literature on FDI by providing evidence on the effects of expropriation risk that affects the international investor's decision to invest in less developed countries. Expropriation is defined as the forced divestment of equity ownership of a foreign direct investor.[4] Given the definition, (Kobrin 1984) collects data on the expropriations of foreign firms in 79 less developed countries from 1960-1979, while (Minor 1994) analyzes expropriation acts from 1980-1992, extending the work of (Kobrin 1984). These studies find that there has been a total of 575 expropriation acts in the 1960-1992 period, mainly concentrated in the agriculture, mining, petroleum, manufacturing and finance industries. (Kobrin 1984) finds that the outright nationalization of sectors such as oil, mining and petroleum, where foreign ownership was not compatible with autonomous

[3](IMF 1993) defines FDI as "an investment made to acquire lasting interest in enterprises operating outside of the economy of the investor. Further, in cases of FDI, the investor's purpose is to gain an effective voice in the management of the enterprise." (OECD 1996) emphasizes that "The most important characteristic of FDI, which distinguishes it from foreign portfolio investment, is that it is undertaken with the intention of exercising control over an enterprise."

[4]Kobrin (1980, 1984) identifies four different kinds of expropriation: *Formal Expropriation*, where the host country's government directly takes over the foreign property under the local law; *Intervention*, where the transfer of ownership is forced, most of the time sudden and unannounced; *Forced Sale*, where the host government uses coercive power to force foreign investors to involuntarily sell their ownership; and *Contract Renegotiation*, where the host government forces renegotiation of the initial contract to force a transfer of ownership.

economic control or national security, was complete by 1975.[5] I show that even though international investors might not face the same risks of nationalization as in the 1960s and 1970s, expropriation risk still affects the decisions of international investors.

The structure of the paper is organized as follows. Section 2 presents the theoretical model. Section 3 presents and analyzes the solution to the the model. Section 4 presents the econometric model, data description, estimation, empirical results, and sensitivity analysis. Section 5 concludes.

2 Model

2.1 The Problem

The basic framework builds on (Thomas and Worrall 1994) and (Albuquerque 2003). A host country receives two types of capital flows from the international investor to produce his consumption good. One is FDI flows, which includes physical capital, k_f, and human capital, h_f. The physical part of FDI can only be operated with foreign human capital. The other type of capital flow the host country receives is non-FDI flows, k_o, which does not require foreign human capital to be operated. Human capital is a proxy for the intangible part of FDI, so if the host country decides to confiscate output, he will be able to keep the physical capital, but the human capital portion will be lost and will not be used in production. I also suggest that the host country will not be able to receive capital flows in the future, and will have to live in autarky forever. Similarly, the international investor has the option of withdrawing her investment, and not investing in the host country in the future.

I assume that the host country is risk averse and the international investor is risk neutral. So, the international investor will invest in the host country as long as she receives the gross rate of return $(1+r)$ on physical capital, the wage rate (w) on human capital, and

[5] See also (Kobrin 1980) and (Minor 1994).

the physical capital is not expropriated by the host country. After the investor makes the investment decision, an aggregate productivity shock, s, is realized that determines the quantity of output produced. Then, the host country decides how much to consume, c_s, out of the output produced, and the international investor will retain the profit, π_s, after transferring c_s to the host country and paying for the factor inputs.

There is no informational asymmetry between the international investor and the host country. However, the host country may decide to confiscate the output, and likewise the international investor may choose to withdraw her investment. These actions might lead to short run gains, but they might have large costs in the long run. The host country gains ownership of physical capital from FDI flows and non-FDI flows, however he will not be able attract any further capital flows. So, at the beginning of the period the international investor and the host country must agree on a self-enforcing long term contract, where the international investor invests k_f, k_o, and h_f, maximizes her profit, taking into account that the host country has an incentive to default. The international investor has to offer the host country a minimum consumption level, c_s, for the current period, and a lifetime utility, V_s, which is the discounted lifetime utility for the host country so that the host country will stay in the contract. Both the consumption and the lifetime utility of the host country will depend on the aggregate shock that is going to be realized. The self-enfocing contract will specify how much the host country will consume and what will be his lifetime utility for each state s that could be realized. The sequence of events at any time t is illustrated in Figure 1.

I assume that the host country and the international investor discount the future at the same rate $1/(1+r)$, and the international investor maximizes the expected value of her profits:

$$B(V) = \max_{c_s,k_f,k_o,h_f} E\left[\pi_s + \frac{1}{1+r}B(V_s)\,\middle|\, s_{-1}\right], \tag{1}$$

where s_{-1} is the previous period's aggregate shock, and V is the promised discounted lifetime utility of the host country determined in the previous period. Basically the utility of

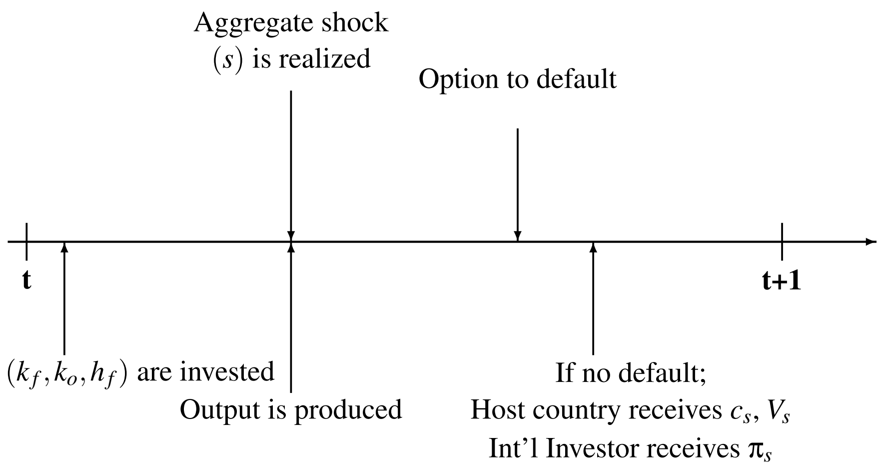

Figure 1: Timing of the events

the international investor is the expected discounted value of her profits, and her utility depends on the host country's discounted lifetime utility. V depends on current consumption of the host country, c_s, and his continuation value for the next period, V_s, contingent on each state s that can be realized in a given period:

$$V = E\left[\ln(c_s) + \frac{1}{1+r}V_s \middle| s_{-1}\right], \tag{2}$$

and $V_s \geq V_{min}$ with $V_{min} > -\infty$, where this constraint is introduced to place a lower bound to the utility of the host country. Equation (2) is the promise-keeping constraint, which states that the lifetime discounted utility of the host country will be equal to the promised value V that is determined in the previous state s_{-1}. The international investor takes V as a state variable and decides how much to invest, how much the host country will consume, and the continuation value V_s for the host country.

Per-period profit for the international investor is defined as:

$$\pi_s = s\,A\left\{\left[(1-a)\,h_f^{\varepsilon} + a\,k_f^{\varepsilon}\right]^{\frac{1}{\varepsilon}}\right\}^{\alpha_f} + s\,k_o^{\alpha_o} - wh_f - (1+r)(k_f+k_o) - c_s. \tag{3}$$

Total output in the economy comes from two investment projects: one using FDI flows -

physical capital (k_f) and human capital (h_f); and the other using non-FDI flows (k_o). In the production function that utilizes FDI, physical and human capital are aggregated in CES fashion with an elasticity of substitution $\sigma \equiv 1/(1-\varepsilon)$. This means that as ε approaches zero, σ approaches unity, and the production function becomes Cobb-Douglas where physical capital and human capital are complements. As ε approaches one, σ approaches infinity, and the production function becomes linear, where physical capital and human capital are perfect substitutes.

I restrict $\varepsilon < \alpha_f$, which is a restriction on the complementarity among human capital portion of FDI, physical capital portion of FDI and non-FDI flows. When $\varepsilon < \alpha_f$, human capital of FDI is more complementary to physical capital of FDI than to non-FDI.

Many host countries offer special tax incentives or subsidies for international investors to attract FDI. A is a constant to capture these benefits and whenever $A > 1$, there are tax advantages of FDI for the international investor. Eventually, total output in the host country is divided between payments to the factors of production and the transfer to the host country. I assume that all capital flows depreciate fully after each period for analytical tractability.

As the production takes place in the host country, he has the option to confiscate output and default on the contract. In turn this leads to the participation constraint for the host economy:

$$\ln(c) + \frac{1}{1+r} V_s \geq U^{aut}(k_f, k_o, s) \tag{4}$$

for every $s \in S$, where S is the space of possible realizations of s. The participation constraint basically states that not expropriating should yield a higher utility to the host country than defaulting on the contract. In case of default, the host country no longer receives FDI or non-FDI flows, and the function $U^{aut}(.)$ gives the future discounted value of the host country's utility under autarky. This condition will generate endogenous barriers to international capital flows by limiting the size of k_f and k_o. Likewise, the participation constraint for the foreign investor requires that the utility of the foreign investor which is equal to her expected present discounted value of profits should always be non-negative to prevent losses, which implies:

$$B(V_s) \geq 0 \text{ for all } s \in S. \tag{5}$$

In summary, the international investor and the host country agree on a self-enforcing long term contract, where the international investor maximizes her profits, makes the investment at the beginning of the period promising the host country the consumption c_s for this period, and promising for the next period the continuation value V_s contingent on the state s that is to be realized. Next, upon the realization of the aggregate productivity shock, s, the output is produced and both parties decide whether to continue the contract or not. If the host country decides to default and confiscate the output, he will not receive any further capital flows in the future. As is customary, I assume that the aggregate shock follows a first order autoregressive process:

$$\ln s_{t+1} = \rho \ln s_t + \varepsilon_{t+1}, \text{ and } \varepsilon_{t+1} \sim N(0, \sigma_\varepsilon^2).$$

2.2 Value under Autarky

To calculate the value for the host country when it defaults and stays in autarky thereafter, I make the following assumptions: (1) Default occurs on both FDI and non-FDI flows simultaneously; (2) During the period when default occurs, foreign human capital is withdrawn, and is no longer employed. The FDI technology is operated without the human capital and there is a loss in FDI output; (3) After default, even though there is no capital flowing to the host country, the host country can still operate the existing physical capital and produce output using the technology of the non-FDI investment project. Following these assumptions, I can write the value of the host country under autarky as

$$U^{aut}(k_f, k_o, s) = \max_{k_o, c \geq 0} \left[\ln(c) + \frac{1}{1+r} E\,\mathcal{U}(k_o, s) \right]$$

subject to the resource constraint

$$A\,s\left(a^{1/\varepsilon}\,k_f\right)^{\alpha_f} + s\,k_o^{\alpha_o} = c + k_o'.$$

Once the host country defaults, the Bellman equation under autarky is:

$$\mathcal{U}(k_o, s) = \max_{k_o', c \geq 0} \left[\ln(s k_o^{\alpha_o} - k_o') + \frac{1}{1+r} E\,\mathcal{U}(k_o', s') \right].$$

The assumptions of log-utility and full depreciation allow me to write the present discounted value of defaulting on the contract and staying under autarky as:

$$U^{aut}(k_f, k_o, s) = d_0 + d_1 \ln\left[A\ \left(a^{1/\varepsilon}\,k_f\right)^{\alpha_f} + k_o^{\alpha_o} \right] + d_2 \ln(s), \tag{6}$$

where the constants d_0, d_1, and d_2 are all positive and $0 < \varepsilon < \alpha_f$.

I also put the restriction $\varepsilon > 0$, because when the human capital is withdrawn (i.e $h_f = 0$) the utility under autarky will not depend on physical capital portion of FDI, and there will be no incentive for the host country to default on FDI.

3 Solution to the Dynamic Problem

The international investor's problem can be written as the maximization of the expected discounted value of profits (Equation (7)), subject to the promise-keeping constraint (Equation (8)), participation constraint for the host country (Equation (9)), the participation constraint for the international investor (Equation (10)), and the lower bound for the host utility constraint (Equation (11)):

$$B(V) = \max_{c_s,k_f,k_o,h_f} E\left[\pi_s + \frac{1}{1+r}B(V_s)\,\middle|\, s_{-1}\right], \tag{7}$$

$$\pi_s = s\,A\left(\left((1-a)\,h_f^{\varepsilon} + a\,k_f^{\varepsilon}\right)^{\frac{1}{\varepsilon}}\right)^{\alpha_f} + s\,k_o^{\alpha_o} - wh_f - (1+r)(k_f+k_o) - c_s,$$

$$V = E\left[\ln(c_s) + \frac{1}{1+r}V_s\,\middle|\, s_{-1}\right], \tag{8}$$

$$\ln(c_s) + \frac{1}{1+r}V_s \geq U^{aut}(k_f,k_o,s) \qquad \forall s \in S, \tag{9}$$

$$B(V_s) \geq 0 \qquad \forall s \in S, \tag{10}$$

$$V_s \geq V_{min} \qquad \forall s \in S, \tag{11}$$

where $U^{aut}(.)$ is defined in Equation (6). I denote σ, $\varphi_s\mu_s$, $\varphi_s\frac{\phi_s}{1+r}$, and $\varphi_s\frac{\tau_s}{1+r}$ as the Lagrange multipliers associated with the constraints, (8), (9), (10), and (11) respectively, where φ_s is the probability of state s occuring given that state s_{-1} has occurred in the previous period.

The first order conditions for the investor's problem with respect to c_s, V_s, h_f, k_f, and k_o, and the envelope condition are, respectively:

$$c_s = \sigma + \mu_s \qquad \forall s \in S, \tag{12}$$

$$B'(V_s) = -\frac{\sigma + \mu_s + \tau_s}{1+\phi_s} \qquad \forall s \in S, \tag{13}$$

$$\varphi_s\,sA\alpha_f\,(1-a)\left((1-a)\,h_f^{\varepsilon} + a\,k_f^{\varepsilon}\right)^{\frac{\alpha_f}{\varepsilon}-1} h_f^{\varepsilon-1} = w \qquad \forall s \in S, \tag{14}$$

$$\varphi_s\,sA\,\alpha_f\,a\left((1-a)\,h_f^{\varepsilon} + a\,k_f^{\varepsilon}\right)^{\frac{\alpha_f}{\varepsilon}-1} k_f^{\varepsilon-1} = 1 + r + \varphi_s\,\mu_s\,U_{k_f}^{aut}(k_f,k_o,s) \qquad \forall s \in S, \tag{15}$$

$$\varphi_s\,s\,\alpha_o\,k_o^{\alpha_o-1} = 1 + r + \varphi_s\,\mu_s\,U_{k_o}^{aut}(k_f,k_o,s) \qquad \forall s \in S, \tag{16}$$

$$B'(V) = -\sigma \tag{17}$$

together with the complementary slackness conditions (omitted). In equations (15) and (16), the marginal productivity levels of physical FDI flows and non-FDI flows are equal to the risk free return, $(1+r)$, plus a default premium, which measures the marginal cost of higher incentives to default caused by a marginal increase in capital. These two equations define the financing constraints of the host economy. When the host country's participation constraint is binding (i.e. $\mu_s > 0$), then the host country faces a positive default premium. If the host country is not financially constrained (i.e. $\mu_s = 0$), then both the physical capital flows earn their marginal products.

3.1 First Best

When there is no enforcement problem, the participation constraints of the host country, (Equation 9) and the international investor (Equation. 10) are no longer needed. By setting $\mu_s = 0$, I show that the first best solution is such that:

Proposition 1 *(i) $c_s^{FB}(V) = \sigma^{FB}$, $\sigma^{FB} = -B^{FB\prime}(V)$; and (ii) c_s^{FB} is a non-decreasing function of V.*

Under the first-best solution, consumption is equal to the slope of the Pareto frontier i.e., $c_s = c = \sigma^{FB} = -B^{FB\prime}(V)$, hence it depends on the promised utility V, but not on the aggregate shock s. The returns to both physical capital flows (Equations 15 and 16) are equalized, and the optimal levels of (h_f, k_f, k_o), denoted with superscript FB, solves;

$$\varphi_s\, s A\, \alpha_f\, (1-a) \left((1-a) + a \left(\frac{k_f^{FB}}{h_f^{FB}} \right)^{\varepsilon} \right)^{\frac{\alpha_f}{\varepsilon}-1} \left(h_f^{FB} \right)^{\alpha_f - 1} = w\,, \tag{18}$$

$$\varphi_s\, s A\, \alpha_f\, a \left((1-a) \left(\frac{h_f^{FB}}{k_f^{FB}} \right)^{\varepsilon} + a \right)^{\frac{\alpha_f}{\varepsilon}-1} \left(k_f^{FB} \right)^{\alpha_f - 1} = 1+r\,, \tag{19}$$

$$\varphi_s\, s\, \alpha_o \left(k_o^{FB} \right)^{\alpha_o - 1} = 1+r\,. \tag{20}$$

There is no default risk associated with physical capital flows, and the marginal products of physical capital flows are equal. Also, the ratio of the marginal product of human capital and physical FDI flows gives us the relation between the two as:

$$\frac{k_f^{FB}}{h_f^{FB}} = \left(\frac{w}{1+r}\,\frac{a}{1-a}\right)^{\frac{1}{1-\varepsilon}}. \tag{21}$$

This states that the ratio of human capital to physical FDI flows is constant and does not depend on the aggregate shock s.

3.2 States when the Participation Constraint Binds

When the participation constraint of the host country is binding (i.e. $\mu_s > 0$), there is a default premium on both physical capital flows, which lead to a reduction of the level of physical FDI and non-FDI flows and a deviation from the first-best level of human capital. The following proposition summarizes the relation between the first-best levels of k_f, k_o, and h_f and the optimal levels in the imperfect enforcement environment:

Proposition 2 *(i) The ratio of physical FDI flows to human capital is lower than the first best: $k_f^*/h_f^* < k_f^{FB}/h_f^{FB}$, (ii) physical FDI flows, non-FDI flows, and human capital are below their first best levels: $k_f^* < k_f^{FB}$, $k_o^* < k_o^{FB}$, and $h_f^* < h_f^{FB}$.*

Proof. In Appendix. ◇

The first part of the proposition states that there is a decline in physical FDI per unit of human capital. This also implies that the change in the level of human capital from the first-best is smaller than the change in physical FDI flows, $h_f^{FB}/h_f^* < k_f^{FB}/k_f^*$. The reason for this difference stems from the possibility that the host country may confiscate output and will keep the current physical FDI flow, however the human capital can be recovered by the international investor.

The second part of the proposition states that when the participation constraint binds, there is under investment in the host country, which is due to the possibility that the host country may default on the contract. Hence, there is a deviation of returns from marginal products, and the extent of the default premium on physical capital flows depends on μ_s, $U_{k_f}^{aut}$ and $U_{k_o}^{aut}$. The following proposition holds:

Proposition 3 *The default premium on physical FDI flows is lower than the default premium on non-FDI flows if* $\alpha_f/\varepsilon - 1 > 0$.

Replacing the values for $U_{k_f}^{aut}$ and $U_{k_o}^{aut}$ in equations (15) and (16) and rearranging yields:

$$\frac{1+r}{MPK_f} = 1 - \underbrace{\left(\frac{1}{1+\frac{1-a}{a}\left(\frac{h_f}{k_f}\right)^{\varepsilon}}\right)^{\frac{\alpha_f}{\varepsilon}-1}}_{\Omega} \frac{\varphi_s \mu_s d_1}{s\left(Aa^{\frac{\alpha_f}{\varepsilon}} k_f^{\alpha_f} + k_o^{\alpha_o}\right)}, \tag{22}$$

$$\frac{1+r}{MPK_o} = 1 - \frac{\varphi_s \mu_s d_1}{s\left(Aa^{\frac{\alpha_f}{\varepsilon}} k_f^{\alpha_f} + k_o^{\alpha_o}\right)}, \tag{23}$$

where MPK_f is the marginal product of physical FDI flows and MPK_o is the marginal product of non-FDI flows. As can be seen from these two equations, the marginal products of both physical capital flows will deviate from the gross return $1+r$ if the participation constraint of the host country is binding, i.e., $\mu_s > 0$. Moreover, if the participation constraint binds, the returns of capital flows will differ if and only if $\Omega \neq 1$. The default premium on physical FDI flows is less than the default premium on non-FDI flows as long as MPK_f is less than MPK_o, i.e., $\Omega < 1$.[6] And Ω is smaller than 1 if $\alpha_f/\varepsilon - 1 > 0$, where the last condition is a constraint on the complementarity between human capital and physical capital flows as mentioned earlier. If human capital is more complementary to physical FDI flows than non-FDI flows, the default premium on FDI flows is smaller than the default premium on non-FDI flows. One should also notice that if FDI flows did not have an intangible part, i.e., if the share of human capital, $1-a$, were zero, then the default premiums on both FDI flows and non-FDI flows would be the same. Hence, one can establish the following:

[6]Proof in Appendix.

Proposition 4 *(i) A higher* h_f^*/k_f^* *will be associated with a lower* Ω*; (ii) The share of FDI flows in total capital flows will be higher than in the first-best when* $\alpha_f = \alpha_o$ *and* $\alpha_f/\varepsilon - 1 > 0$.

Proof. In Appendix. ◇

The first part of the proposition states that when the default premium on physical FDI flows is lower than the default premium on non-FDI flows, an increase in human capital per physical FDI flows implies a decrease in Ω, and hence a bigger discrepancy between default premia. This makes it more profitable for the international investor to invest more heavily in FDI flows. Therefore, an increase in human capital flow implies a higher share of FDI. Likewise, if the default premium on FDI flows is higher than the default premium on non-FDI flows, an increase in the human capital per physical FDI implies a decrease in Ω. As Ω is approaching unity, there will be a lower discrepancy between default premia. This will imply that an international investor could decrease the difference between the physical capital returns by increasing the human capital flow per FDI flow.

Proposition 2 states that when we move from First Best to an Imperfect Enforcement Environment, i.e, if a country is financially constrained, there will be a decrease in the amount of capital it can attract from foreign investors. The second part of Proposition 4 states that when a country is financially constrained, the share of FDI flows in total capital flows will be higher, under the assumption that the production technologies share the same α.

4 Empirical Work

In this section I test the predictions in Proposition 4: that the share of FDI is higher for countries that are more financially constrained, and that there is a positive association between human capital flowing into a host country and FDI. The main regression equation to be estimated is as follows:

$$k_{it} = \beta_1 + \underbrace{\alpha}_{+} \text{ Rating Dummies}_{it} + \underbrace{\beta_2}_{+} \text{ Spillover}_{it} + \underbrace{\beta_3}_{-} \text{ Spillover}_{it} * \text{Rating}_{it} + \gamma \text{Controls}_{it} + v_i + e_{it}. \quad (24)$$

Here k_{it} represents the share of net FDI inflows in private capital flows in country i at time t, taken from the World Development Indicators (WDI). Following (Albuquerque 2003), I use Moody's sovereign credit ratings as a measure of financing constraints and use them as dummies (*Rating Dummies*$_{it}$) in the regression. To proxy the human capital that is embedded in FDI flows, I created a spillover variable (*Spillover*$_{it}$), following (Coe and Helpman 1995), which will be explained below. They also use this variable as a proxy for the international research and development spillovers coming through FDI. If spillovers are sizeable, one would expect that the share of FDI would be larger. I also included an interaction term between spillovers and ratings to capture the effect of financial constraints on the share of FDI through spillovers. As ratings improve (hence as financial constraints are relaxed), the positive effect of spillovers will be reduced. I expect that if spillovers are large, financial constraints would be less binding, and the share of FDI would decline since the country would be able to attract larger non-FDI capital flows.

As main control variables, I use GDP per capita (PPP-adjusted in constant 2000 dollars) to control for country size. As other studies noted financial development is also an important factor in explaining foreign capital flows.[7] Hence, I include a stock market development measure and a banking sector development measure to capture different aspects of financial development. To control for stock market development, I use either the ratio of the total value of shares traded on the stock market to GDP, or the ratio of stock market capitalization to GDP. Both of these measures are taken from Beck, Demirguc-Kunt and Levine (2000). To capture banking sector development, I use the ratio of liquid liabilities to GDP or the ratio of private credit by deposit money banks to GDP, from (Beck, Demirguc-Kunt and

[7] See (Alfaro, Kalemli-Ozcan and Sayek 2004)

Levine 2000). To control for the level of human capital in the host country, I use average years of schooling, *Schooling*, from the (Barro and Lee 2000) dataset . Finally to measure trade openness, *Openness*, I use the total share of exports and imports in GDP from WDI.

As mentioned above, I use Moody's sovereign credit ratings as a measure of financing constraints. Moody's foreign currency ratings are classified as Aaa, Aa, A, Baa, Ba, B, Caa, Ca, C, and in each category there is a number assigned 1, 2, 3 from high to low rank, which I aggregated. Aaa rating is considered to identify countries that are not financially constrained and refers to the first-best solution in the theoretical model. It is taken as the reference category, and not included in the regression. This implies that going from an Aaa rating to a lower rating should imply a higher FDI share, hence a positive coefficient on the rating dummies.

Figure 2 shows the association between the share of FDI flows in total capital flows and countries' credit ratings. As can be seen, there is a negative association between credit rating and the share of FDI. A lower rating implies that a country is more financially constrained and faces a higher default premium on both types of capital flows. Moreover, as the default premium on FDI is lower, the country ends up having a larger share of FDI compared to countries that are less financially constrained and enjoy higher ratings.

Following (Coe and Helpman 1995) the proxy for the international research and development spillovers is:

$$Spillover_{it} = \sum_{j} s_{jit} * rd_{jt} \tag{25}$$

where the subscript i refers to the host country, j refers to the international investor (a G7 country), and t refers to the time period. Given that most of R&D takes place in G7 countries, I consider the gross domestic expenditure on R&D (GERD) and business enterprise expenditure on R&D (BERD) in G7 countries as the main source of human capital flows.[8,9]

[8] Also, the data on the FDI inflow shares for individual countries was very limited. As a sensitivity check, I also consider a simple average of the R&D stocks in G7 countries instead of a weighted sum.

[9] The calculations for R&D stocks are in the Appendix.

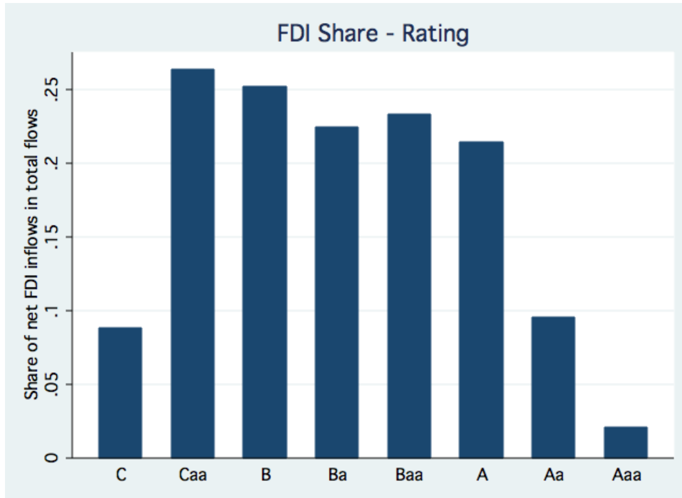

Figure 2: Average share of net FDI inflows in total capital inflows by sovereign rating

So, the inflow of R&D into country i in year t, rd_{jt}, is a weighted sum of the real R&D stocks (rd_{jt}) in G7 countries. The weights s_{jit} are calculated as the FDI inflow from a G7 country j into the host country, as a share of total FDI flows into host country i from all G7 countries. The relation between spillovers and the share of FDI in total capital flows is presented in Figure 3. The relationship does not appear to be linear, so I experiment with the square of the variable in the regression as a sensitivity check.

The data set is an unbalanced panel data set with 44 countries, over the years 1981-2004 due to missing observations in the data. For the estimation, I experiment with both random and fixed effects. In Table 1 the first two columns show the main relation between credit ratings and FDI shares for fixed and random effects, respectively. As expected, the coefficients on the rating dummies are significant and positive, implying that moving from the rating Aaa to a lower rating is associated with an increase in the share of FDI flows.

The third column of Table 1 uses GERD for the calculation of spillover effects and the fourth column uses BERD. I also include Stock Market Total Value Traded / GDP, Liquid Liabilities / GDP, and GDP as additional control variables. An increase in the R&D spillover measure implies a significantly higher share of FDI. However, the negative and

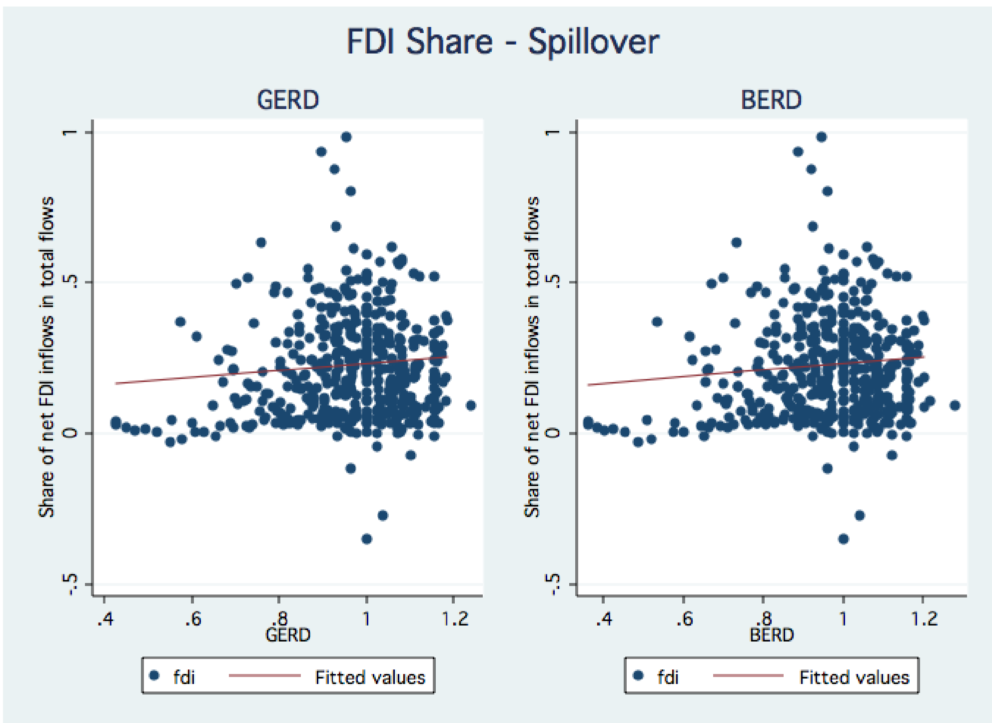

Figure 3: Average share of net FDI inflows in total capital inflows and Spillovers

Table 1: Main Effects

	(1)-FE	(2)-RE	(3)-FE	(4)-FE	(5)-RE	(6)-RE
Aa	0.495	0.462	1.297	1.369	1.891	1.934
	(0.503)	(0.500)	(0.766)+	(0.756)+	(0.780)*	(0.801)*
A	1.411	1.411	1.589	1.666	2.358	2.405
	(0.302)**	(0.395)**	(0.756)*	(0.742)*	(0.796)**	(0.820)**
Baa	1.628	1.654	1.792	1.870	2.525	2.573
	(0.192)**	(0.375)**	(0.696)*	(0.680)**	(0.811)**	(0.837)**
Ba	1.647	1.668	1.815	1.891	2.563	2.609
	(0.103)**	(0.373)**	(0.710)*	(0.693)**	(0.814)**	(0.840)**
B	1.810	1.856	1.832	1.916	2.701	2.750
	(0.162)**	(0.351)**	(0.709)*	(0.683)**	(0.826)**	(0.852)**
Caa	1.865	1.926	1.779	1.864	2.635	2.687
	(0.180)**	(0.368)**	(0.758)*	(0.735)*	(0.848)**	(0.872)**
C	1.121	1.135	0.820	0.921	1.705	1.773
	(0.356)**	(0.434)**	(0.628)	(0.610)	(0.830)*	(0.855)*
GERD			3.914		4.037	
			(1.905)*		(1.296)**	
GERD*Rating			-0.498		-0.619	
			(0.275)+		(0.218)**	
BERD				3.596		3.618
				(1.808)+		(1.215)**
BERD*Rating				-0.462		-0.553
				(0.249)+		(0.200)**
Stock Market Total Value Traded / GDP			0.114	0.115	0.065	0.065
			(0.053)*	(0.053)*	(0.032)*	(0.032)*
Liquid Liabilities / GDP			-0.248	-0.228	-0.253	-0.243
			(0.382)	(0.387)	(0.165)	(0.164)
GDP			-1.015	-1.001	0.030	0.028
			(0.444)*	(0.440)*	(0.139)	(0.139)
Constant	-3.510	-3.492	4.827	4.655	-4.506	-4.528
	(0.078)**	(0.366)**	(3.844)	(3.763)	(1.555)**	(1.569)**
R^2	0.1633	0.1627	0.0283	0.0285	0.1097	0.1093
N	464	464	406	406	406	406

Standard errors in parentheses

+ $p < 0.10$, * $p < .05$, ** $p < .01$

significant coefficients on the interaction terms mean that as spillovers increase, a higher rating is associated with a lower share of FDI. In other words, when foreign human capital increases, the positive effect of spillovers on the share of FDI is reduced through higher ratings. Stock market development has a positive and significant impact on the share of FDI, but banking sector development has no significant effect. Finally, GDP has a negative and significant effect on the share of FDI. In columns 5 and 5, I replicate my analysis in columns 3 and 4 using random effects. The estimation results are still significant and have the expected signs.

In Table 2 I use additional control variables to test my hypothesis using fixed effects regressions. In columns 1 and 2 I include openness and schooling as additional control variables. The main results do not change: lower ratings imply an increased share of FDI and higher spillovers imply higher FDI shares. However, I still have a significant and negative coefficient on the interaction term. Stock market development has a positive and significant influence on the FDI share, but banking development still has no significant effect. GDP has a significant and negative impact on the share of FDI, in line with my previous findings. Openness has a significant and positive coefficient, implying that if a country is more open to trade, it has a higher share of FDI. Schooling does not have a significant effect. In columns 3 and 4, I replicate the analysis using Private Credit by Deposit Money Banks / GDP instead of Liquid Liabilities / GDP, with similar findings. Next, in columns 5 and 6, I replicate the analysis using Market Capitalization as a measure of stock market development and obtain similar results.

In Table 3 I replicate the analysis in Table 2, but this time using random effects. I also check the validity of the random effects model by employing Hausman Tests between fixed effects and random effects for each regression.[10] I fail to reject the null hypothesis that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator. The random effects results are similar to those in Table 2, but there is a gain in significance. Liquid Liabilities / GDP has a

[10]Results are available upon request.

Table 2: Fixed Effects

	(1)	(2)	(3)	(4)	(5)	(6)
Aa	1.028	1.131	1.084	1.169	0.897	0.998
	(0.749)	(0.755)	(0.750)	(0.751)	(0.962)	(0.962)
A	2.440	2.579	2.469	2.583	2.168	2.308
	(0.964)*	(0.956)*	(1.013)*	(1.004)*	(1.324)	(1.316)+
Baa	2.766	2.918	2.714	2.842	2.553	2.711
	(0.834)**	(0.830)**	(0.951)**	(0.944)**	(1.173)*	(1.168)*
Ba	2.667	2.819	2.580	2.708	2.464	2.621
	(0.833)**	(0.835)**	(0.935)**	(0.931)**	(1.204)*	(1.204)*
B	2.757	2.922	2.690	2.829	2.413	2.585
	(0.868)**	(0.863)**	(0.864)**	(0.854)**	(1.282)+	(1.276)+
Caa	2.562	2.726	2.534	2.672	2.258	2.432
	(0.879)**	(0.866)**	(0.879)**	(0.867)**	(1.241)+	(1.231)+
C	0.655	0.831	0.602	0.750	0.083	0.258
	(0.800)	(0.788)	(0.849)	(0.838)	(1.393)	(1.386)
GERD	5.923		4.987		5.458	
	(2.232)*		(1.521)**		(2.321)*	
GERD*Rating	-0.982		-0.819		-0.917	
	(0.338)**		(0.268)**		(0.378)*	
BERD		5.534		4.682		5.120
		(2.241)*		(1.532)**		(2.301)*
BERD*Rating		-0.932		-0.782		-0.877
		(0.334)**		(0.253)**		(0.366)*
Stock Market Total Value Traded / GDP	0.140	0.140	0.139	0.139		
	(0.062)*	(0.062)*	(0.061)*	(0.062)*		
Stock Market Capitalization / GDP					0.224	0.227
					(0.218)	(0.218)
Liquid Liabilities / GDP	-0.348	-0.337			-0.534	-0.526
	(0.443)	(0.449)			(0.521)	(0.529)
Private Credit by Deposit Money Banks / GDP			-0.140	-0.136		
			(0.395)	(0.394)		
GDP	-1.096	-1.033	-1.206	-1.152	-0.909	-0.841
	(0.567)+	(0.567)+	(0.581)*	(0.579)+	(0.795)	(0.792)
Openness	0.735	0.752	0.581	0.600	0.765	0.782
	(0.256)**	(0.262)**	(0.335)+	(0.338)+	(0.249)**	(0.253)**
Schooling	-0.294	-0.282	-0.242	-0.233	-0.337	-0.322
	(0.465)	(0.457)	(0.456)	(0.449)	(0.504)	(0.495)

Standard errors in parentheses
+ $p < 0.10$, * $p < .05$, ** $p < .01$

Table 3: Random Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Aa	1.810	1.893	1.777	1.844	1.640	1.698	1.198	1.291
	(0.833)*	(0.807)*	(0.868)*	(0.849)*	(0.889)+	(0.862)*	(1.026)	(1.024)
A	3.272	3.384	3.223	3.317	3.010	3.104	2.773	2.917
	(0.847)**	(0.825)**	(0.884)**	(0.870)**	(0.917)**	(0.897)**	(1.031)**	(1.032)**
Baa	3.622	3.750	3.489	3.598	3.363	3.474	3.130	3.305
	(0.849)**	(0.830)**	(0.901)**	(0.890)**	(0.915)**	(0.897)**	(1.049)**	(1.054)**
Ba	3.606	3.735	3.435	3.545	3.326	3.438	3.100	3.272
	(0.852)**	(0.835)**	(0.906)**	(0.896)**	(0.922)**	(0.906)**	(1.050)**	(1.055)**
B	3.822	3.955	3.670	3.784	3.441	3.557	3.294	3.481
	(0.854)**	(0.836)**	(0.892)**	(0.881)**	(0.939)**	(0.922)**	(1.054)**	(1.061)**
Caa	3.666	3.801	3.567	3.681	3.340	3.459	3.140	3.329
	(0.885)**	(0.867)**	(0.921)**	(0.911)**	(0.954)**	(0.937)**	(1.078)**	(1.084)**
C	1.874	2.023	1.730	1.856	1.351	1.479	1.380	1.574
	(0.850)*	(0.828)*	(0.910)+	(0.897)*	(0.994)	(0.976)	(1.036)	(1.038)
GERD	6.805		5.595		6.166		6.248	
	(1.562)**		(1.322)**		(1.551)**		(1.538)**	
$GERD^2$							-4.491	
							(1.973)*	
GERD*Rating	-1.258		-1.055		-1.152		-1.323	
	(0.260)**		(0.233)**		(0.264)**		(0.275)**	
BERD		6.301		5.183		5.697		6.032
		(1.481)**		(1.259)**		(1.465)**		(1.458)**
$BERD^2$								-3.970
								(1.688)*
BERD*Rating		-1.170		-0.982		-1.070		-1.288
		(0.243)**		(0.218)**		(0.245)**		(0.263)**
Stock Market Total Value Traded / GDP	0.095	0.095	0.088	0.087			0.069	0.069
	(0.038)*	(0.038)*	(0.037)*	(0.037)*			(0.035)+	(0.035)+
Stock Market Capitalization / GDP					0.170	0.173		
					(0.097)+	(0.097)+		
Liquid Liabilities / GDP	-0.403	-0.396			-0.518	-0.513	-0.368	-0.344
	(0.234)+	(0.232)+			(0.259)*	(0.258)*	(0.209)+	(0.205)+
Private Credit by Deposit Money Banks / GDP			-0.245	-0.243				
			(0.189)	(0.189)				
GDP	-0.055	-0.049	-0.086	-0.080	-0.054	-0.048	-0.009	-0.001
	(0.238)	(0.238)	(0.246)	(0.246)	(0.232)	(0.232)	(0.232)	(0.232)
Openness	0.390	0.400	0.256	0.268	0.386	0.395	0.372	0.378
	(0.222)+	(0.222)+	(0.202)	(0.201)	(0.222)+	(0.222)+	(0.215)+	(0.214)+
Schooling	0.367	0.378	0.442	0.454	0.342	0.352	0.135	0.144
	(0.432)	(0.431)	(0.445)	(0.444)	(0.437)	(0.437)	(0.463)	(0.460)

Standard errors in parentheses
+ $p < 0.10$, * $p < .05$, ** $p < .01$

significant and negative effect on the FDI share. I also find that stock market development has a positive impact on the FDI share, whereas banking sector development has a negative effect or no effect at all. What is surprising is that the Schooling variable which captures the education level in the host country is positive but do not have a significant effect.

I also experimented by putting the square of the spillover variable in the regression based on the seemingly non-linear relation between the FDI share and the spillover measure in Figure 3. The squared term has a negative and significant effect and the interaction between rating and the spillover is still negative and significant. This finding implies that higher levels of spillovers have a diminishing influence on the share of FDI flows. Schooling variable again does not have a significant sign. This might be due to the fact that there might be a relation between the education level of the host country which is not explicitly modeled in this paper, the human capital spillovers from FDI and the share of FDI.

5 Conclusion

Using a dynamic contracting model with human capital, I show that when intangible assets that are embedded in FDI flows, but not in non-FDI flows, the composition of capital flows to developing countries is altered. I assume that foreign investors provide the host country with intangible assets such as managerial services, organizational capabilities, and engineering experience, together with physical capital such as plants, equipment and inventories. The physical and human capital aspects of FDI differ because physical capital can be confiscated by the host country but human capital cannot. Therefore, the host country has to weigh benefits and costs when making default decisions. The host country may gain from confiscating the output in the short run. However, all subsequent investment returns are lower because human capital cannot be confiscated, and the host country loses all future foreign capital investments. Hence, the risk premium on FDI flows is lower than the risk premium on non-FDI flows, and the share of FDI flows in total capital flows is higher for more financially constrained countries. In addition, there is a positive association between human capital flows and the share of FDI flows, and the positive association between human capital and FDI becomes weaker as degree of financing constraints decrease.

To test the empirical predictions of the model, I constructed a measure of intangible assets in FDI following (Coe and Helpman 1995). Using an unbalanced panel dataset, I find empirical support for the following propositions: a) More financially constrained countries have a higher share of FDI in total capital flows; b) There is a positive association between human capital flows and the share of FDI in total capital flows; c) The positive association between human capital flows and FDI flows is weaker for less financially constrained countries.

Future research might enrich the model by explicitly modeling the human capital in the host country and and examining how it might affect the association between human capital spillovers and the share of FDI. There might be a direct transfer and diffusion of technology and management to host country nationals.Through human capital spillovers, the host country may gain enough skills such that there may be a tendency for host governments to perceive the need to exert increased control over foreign investors and an improvement in their capability to do so. This might imply that the host country may find it optimal to default. On the other hand, spillovers from foreign human capital may imply an increase in expected future gains from FDI flows, which might provide further incentive for the host country not to default. So, a country with large spillovers coming from FDI might have a lower default premium on FDI. There are two opposing effects and depending on the size of the spillovers, there might be an increase or decrease in the likelihood of default.

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1 Appendix A

Table 4: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Share of FDI	0.226	0.162	0.001	0.984	410
GERD	0.967	0.132	0.426	1.188	410
BERD	0.964	0.141	0.362	1.205	410
Stock Market Total Value Traded / GDP	0.124	0.242	0	2.297	405
Stock Market Capitalization / GDP	0.337	0.419	0	2.824	410
Liquid Liabilities / GDP	0.485	0.286	0.076	1.366	410
Private Credit by Deposit Money Banks / GDP	0.395	0.305	0.058	1.66	410
GDP	8.026	0.767	5.684	9.818	410
Openness	4.204	0.599	2.584	5.433	405
Schooling	6.296	1.787	2.292	9.904	309

2 Appendix B

2.1 Proof of Proposition 2

Part (i) : From Eqn. (21) we have the optimal FDI inflow to human capital ratio as:

$$\frac{k_f^{FB}}{h_f^{FB}} = \left(\frac{w}{1+r} \frac{a}{1-a} \right)^{\frac{1}{1-\varepsilon}}, \tag{26}$$

and the counterpart when the participation constraint binds:

$$\frac{k_f^*}{h_f^*} = \left(\frac{w}{1+r+\text{Default Premium}_{k_f}} \frac{a}{1-a} \right)^{\frac{1}{1-\varepsilon}}. \tag{27}$$

Since the default premium is positive, we have $(k_f^{FB}/h_f^{FB}) > (k_f^*/h_f^*)$.

Part (ii) : Looking at the first order conditions for physical capital flows in the first best, Eqn. (19) and Eqn (20), it is known that $MPK_f^{FB} = MPK_o^{FB} = 1+r$. Also, from Eqn. (15) and Eqn. (16), it is known that when the participation constraint binds ($\mu > 0$), we have $MPK_f^* = 1+r+$ Default Premium$_{k_f}$, and $MPK_o^* = 1+r+\text{Default Premium}_{k_o}$, where both of the default premiums are positive. These will imply that $MPK_f^{FB} < MPK_f^*$ and $MPK_o^{FB} < MPK_o^*$. Since both of the investment projects are strictly concave, $k_f^* < k_f^{FB}$ and $k_o^* < k_o^{FB}$.

Both under first best and $\mu > 0$, human capital gains its marginal product w. To see how the level of human capital changes, I use the first order conditions in Eqn. (14) and (18), and see how human capital reacts to changes in the k_f to h_f ratio,

$$
\begin{aligned}
h_f &= \frac{\alpha_f\ \varphi_s\ sA(1-a)}{w}\left[(1-a)+a\left(\frac{k_f}{h_f}\right)^{\varepsilon}\right]^{\frac{\alpha_f-1}{\varepsilon(1-\alpha_f)}}, \\
\frac{\partial h_f}{\partial\left(\frac{k_f}{h_f}\right)} &= \frac{\alpha_f\ \varphi_s\ sA(1-a)}{w}\ \frac{\alpha_f-\varepsilon}{1-\alpha}\left[(1-a)+a\left(\frac{k_f}{h_f}\right)^{\varepsilon}\right]^{\frac{\alpha_f-1}{\varepsilon(1-\alpha_f)}-1} a\left(\frac{k_f}{h_f}\right)^{\varepsilon-1} > 0,
\end{aligned}
$$

since $\alpha_f > \varepsilon$. It is also known that there has been an increase in the FDI to human capital ratio, i.e. $(k_f^{FB}/h_f^{FB}) > (k_f^*/h_f^*)$, therefore it can be concluded that $h_f^* < h_f^{FB}$.

2.2 Proof of Proposition 3

The term that is common to both of the first order conditions in Eqn. (22) and Eqn. (23) is positive, and can be denoted as $\chi = \frac{\varphi_s \mu_s d_1}{s\left(Aa^{\frac{\alpha_f}{\varepsilon}} k_f^{\alpha_f} + k_o^{\alpha_o}\right)}$. Then I have,

$$
\begin{aligned}
\frac{1+r}{MPK_f} &= 1-\Omega*\chi, && (28)\\
\frac{1+r}{MPK_o} &= 1-\chi, && (29)
\end{aligned}
$$

where if $\Omega < 1$, then $\frac{1+r}{MPK_f} > \frac{1+r}{MPK_o}$, which in turn implies $MPK_f < MPK_o$. Combining this information with the first order conditions from Eqn. (15) and Eqn. (16), where:

$$
\begin{aligned}
MPK_f &= 1+r+\text{Default Premium}_{k_f}, && (30)\\
MPK_o &= 1+r+\text{Default Premium}_{k_o}, && (31)
\end{aligned}
$$

it can be concluded that $\text{Default Premium}_{k_f} < \text{Default Premium}_{k_o}$.

2.3 Proof of Proposition 4

Part (i) : Using Eqn (22), and taking the derivative of Ω with respect to (h_f/k_f):

$$\Omega = \left(\frac{1}{1 + \frac{1-a}{a} \left(\frac{h_f}{k_f}\right)^{\varepsilon}} \right)^{\frac{\alpha_f}{\varepsilon}-1}, \tag{32}$$

$$\frac{\partial \Omega}{\partial \left(\frac{h_f}{k_f}\right)} = -(\alpha_f - \varepsilon) \left(\frac{1}{1 + \frac{1-a}{a} \left(\frac{h_f}{k_f}\right)^{\varepsilon}} \right)^{\frac{\alpha_f}{\varepsilon}} \frac{1-a}{a} \left(\frac{h_f}{k_f}\right)^{\varepsilon} < 0, \tag{33}$$

as long as $\alpha_f > \varepsilon$.

Part (ii) : I want to show that the FDI share in total capital flows is greater when participation constraint of the host country binds:

$$\frac{k_f^* + h_f^*}{k_f^* + h_f^* + k_o^*} > \frac{k_f^{FB} + h_f^{FB}}{k_f^{FB} + h_f^{FB} + k_o^{FB}} \tag{34}$$

$$\frac{1}{1 + \frac{k_o^*}{k_f^* + h_f^*}} > \frac{1}{1 + \frac{k_o^{FB}}{k_f^{FB} + h_f^{FB}}}$$

$$1 + \frac{k_o^*}{k_f^* + h_f^*} < 1 + \frac{k_o^{FB}}{k_f^{FB} + h_f^{FB}}$$

$$\frac{k_o^*}{k_f^*} + \frac{k_o^*}{h_f^*} < \frac{k_o^{FB}}{k_f^{FB}} + \frac{k_o^{FB}}{h_f^{FB}} \tag{35}$$

Let's have a look at the first order conditions for the first best, where MPK_f and MPK_o are equal, and $\alpha_f = \alpha_o = \alpha$.

$$MPK_o^{FB} = MPK_f^{FB} \tag{36}$$

$$s\,\alpha\,\left(k_o^{FB}\right)^{\alpha-1} = \underbrace{s\,\alpha A\,a \left((1-a) \left(\frac{h_f^{FB}}{k_f^{FB}}\right)^{\varepsilon} + a \right)^{\frac{\alpha_f}{\varepsilon}-1}}_{\Theta^{FB}} \left(k_f^{FB}\right)^{\alpha-1}$$

$$\Theta^{FB} = \left(\frac{k_o^{FB}}{k_f^{FB}}\right)^{\alpha-1} \tag{37}$$

For the states when participation constraint binds, the default premium of FDI flows is less than the default premium on non-FDI flows, hence:

$$
\begin{aligned}
MPK_o &> MPK_f \\
s\,\alpha\,(k_o^*)^{\alpha-1} &> \underbrace{s\,\alpha A\,a\left((1-a)\left(\frac{h_f^*}{k_f^*}\right)^{\varepsilon}+a\right)^{\frac{\alpha_f}{\varepsilon}-1}}_{\Theta^*}\left(k_f^*\right)^{\alpha-1}
\end{aligned}
\tag{38}
$$

$$
\Theta^* < \left(\frac{k_o^*}{k_f^*}\right)^{\alpha-1}. \tag{39}
$$

It is known from Proposition 2 that $(k_f^{FB}/h_f^{FB}) > (k_f^*/h_f^*)$, therefore I can combine Eqn. (37) and Eqn. (39) as:

$$
\begin{aligned}
\left(\frac{k_o^{FB}}{k_f^{FB}}\right)^{\alpha-1} = \Theta^{FB} &< \Theta^* < \left(\frac{k_o^*}{k_f^*}\right)^{\alpha-1} \\
\left(\frac{k_o^{FB}}{k_f^{FB}}\right)^{\alpha-1} &< \left(\frac{k_o^*}{k_f^*}\right)^{\alpha-1} \\
\frac{k_o^{FB}}{k_f^{FB}} &> \frac{k_o^*}{k_f^*}.
\end{aligned}
\tag{40}
$$

The last inequality can also be written as:

$$
\frac{k_o^{FB}}{k_o^*} > \frac{k_f^{FB}}{k_f^*}. \tag{41}
$$

We also know from Proposition 2 that $(k_f^{FB}/k_f^*) > (h_f^{FB}/h_f^*)$ and can write it as follows:

$$
\frac{k_f^{FB}}{k_f^*} > \frac{h_f^{FB}}{h_f^*}. \tag{42}
$$

Combining Equations (41) and (42) will give:

$$
\begin{aligned}
\frac{k_o^{FB}}{k_o^*} > \frac{k_f^{FB}}{k_f^*} &> \frac{h_f^{FB}}{h_f^*} \\
\frac{k_o^{FB}}{k_o^*} > \frac{h_f^{FB}}{h_f^*} &\Rightarrow \frac{k_o^{FB}}{h_f^{FB}} > \frac{k_o^*}{h_f^*}.
\end{aligned}
\tag{43}
$$

The equations (40) and (43) will together satisfy the condition in equation 35.

3 Appendix C

The data on Gross Domestic Expenditure on R&D in million 2000 dollars, constant prices and PPP adjusted (GERD) and Business Enterprise Expenditure on R&D in million 2000 dollars – constant prices and PPP adjusted (BERD) are from OECD Main Science and Technology Indicators. Following Coe, Helpman and Hoffmaister (2008), R&D capital stocks were calculated using the perpetual inventory method:

$$rd_t = (1-\delta)rd_{t-1} + RDE_{t-1},$$

where rd is the R&D capital stock, RDE is the R&D expenditure, and δ is the depreciation rate which is assumed to be 0.05. The benchmarks are calculated as,

$$rd_{1982} = RDE_{1982}/(\delta + g),$$

where g is the annual average logarithmic growth rate of R&D from 1982-2004, i.e., $g = log(RDE_{2004}/RDE_{1982})$ / 22.

Trade Liberalization, Firm Heterogeneity, and Unemployment: An Empirical Investigation

Doctoral Dissertation Chapter 2

Pinar Uysal

Department of Economics

Boston College

Chestnut Hill, MA

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This paper is based on joint work with Yoto V. Yotov, Department of Economics and International Business, Drexel University.

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1 Introduction

Following Melitz (2003), a fast growing literature has been studying the consequences of heterogeneous firms on the effects of trade and trade liberalization.[1] Many of these studies have clear structural predictions about the relationship between trade liberalization and firm-level trade-induced unemployment when firms differ in their total factor productivity. Despite the interest in the role of heterogeneity, however, many of the theoretical implications and relationships of Melitz's model have not yet been tested empirically. In this paper, we make an attempt to narrow this gap by providing empirical evidence for the interaction between firm productivity and trade liberalization in the determination of firm-level, trade-induced unemployment.

Melitz (2003) develops a dynamic industry model with heterogeneous firms to examine the intra-industry effects of international trade. He finds that opening to trade causes the least productive firms to stop producing and the more productive firms to start exporting, as only the more productive firms can bear the fixed trade costs. As a result, market shares are reallocated toward more productive firms, which leads to an aggregate productivity increase and an increase in the zero-profit productivity cutoff, defined as the minimum productivity level needed for a firm to produce domestically. Melitz also shows that trade liberalization results in an increase in the zero-profit productivity cutoff and a decrease in the export productivity cutoff, defined as the minimum productivity level needed for a domestic firm to enjoy profitable exports.

Data limitations do not allow Melitz's predictions to be tested directly. In particular, it is practically impossible to partition firms' profits between their domestically generated portion and the part coming from exports. Our main contribution in this paper is that we are able to quantify the relationship between firm productivity and firm layoffs caused by trade. We do this by concentrating on the labor market and by employing reliable, novel

[1] See Bernard, Redding, and Schott (2007), Egger and Kreickemeier (2007), Helpman, Melitz, and Yeaple (2004) among others.

data that allows us to directly identify *firm-level, trade-induced* unemployment. In addition, we test and find support for important theoretical predictions regarding the direction and magnitude of the changes in the zero-profit productivity cutoff and the export productivity cutoff when a country pursues trade liberalization.

We stay close to the original Melitz framework and introduce tariffs to derive a structural labor equation where the interactions between total factor firm productivity and trade liberalization are the key determinants of the number of workers laid off due to trade. We start by deriving firm-level employment in an autarky equilibrium. Then, we determine the equilibrium number of workers in each firm when the country opens up to costly trade and exercises protection. As a final step, we consider the case of trade liberalization, which is the basis for our empirical analysis. The theoretical predictions of our structural model, derived when a country liberalizes its trade policy, are unambiguous and suggest that, all else equal: a) More productive firms will lay off fewer workers; b) The more a country opens up to trade, the more layoffs there will be in the firms that produce only for the domestic market; c) Firms in more protected industries will suffer fewer layoffs. The intuition behind these findings is also clear: lower trade costs give a competitive edge to the more productive firms that can afford to cover the export entry cost. These firms compete for resources with the less productive domestically producing firms, which forces some of the latter to exit the market and leads to an increase in the zero profit productivity cutoff. In addition, all remaining firms that produce only for the domestic market suffer market share and sales losses, which are accompanied by layoffs.

To test the predictions of our theoretical labor equation empirically, we use US firm-level data for the period 1980-2005. We adopt the methodology from Olley and Pakes (1996) to calculate total factor firm productivity, and we employ the Petition for Trade Adjustment Assistance Dataset, maintained by the Employment and Training Administration of the U.S. Department of Labor, to identify directly the number of workers laid-off due to trade at the firm level. Overall, we find strong empirical support for the structural predictions of our model as well as for some theoretical implications from other studies. We show that, as expected, firm productivity, trade liberalization, and the interactions between them are key determinants of the magnitude of firm-level job destruction. More specifically, we find that a one percent increase in a firm's total factor productivity reduces the number of workers who are laid-off due to trade liberalization by 32%, while, on average, an additional one percent of trade liberalization increases the number of firm-level, trade-induced layoffs by 2%. In addition, we provide empirical support for the following theoretical predictions from Melitz (2003): a) Trade liberalization results in a higher zero-profit productivity cutoff and a lower export productivity cutoff for domestic firms; b) The increase in the zero-profit productivity cutoff for domestic production is larger than the absolute decrease in the export productivity cutoff.

The remainder of the paper is structured as follows. Section 2 presents the theoretical model. Section 3 presents the econometric model, data description, estimation, empirical results, and sensitivity analysis. Section 4 concludes.

2 Theoretical Setting

Our theoretical model follows Melitz (2003). Given our empirical strategy, however, we concentrate on the labor market and analyze the effects of trade and trade liberalization on the equilibrium number of workers employed by each firm.

2.1 Autarky Equilibrium

Consumption. The representative consumer's utility is derived from consumption of a continuum of goods indexed by ω, and takes a CES functional form:

$$U = \left[\int_{\omega \varepsilon \Omega} q(\omega)^{\rho} d\omega\right]^{\frac{1}{\rho}},$$

where $q(\omega)$ is the amount of variety ω consumed, Ω is the mass of potentially available goods, and $\sigma = 1/(1-\rho) > 1$ is the elasticity of substitution between different varieties. The consumer's utility can be considered as an aggregate good, $Q \equiv U$, which is composed of different goods varieties, with a corresponding aggregate price index $P = \left[\int_{\omega\varepsilon\Omega} p(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}$. Making use of the definitions of aggregate consumption and the CES price index, we solve the representative consumer's problem to derive demand, $q(\omega)$, and expenditure, $r(\omega)$, for each individual variety:

$$q(\omega) = Q\left[\frac{p(\omega)}{P}\right]^{-\sigma}, \quad r(\omega) = R\left[\frac{p(\omega)}{P}\right]^{1-\sigma}, \tag{1}$$

where $R = PQ = \int_{\omega\varepsilon\Omega} r(\omega) d\omega$ denotes aggregate expenditure.

Production. There is a continuum of firms, and each of them produces a different variety ω. Production requires only labor and takes the following linear functional form: $l = f + q/\varphi$. All firms pay the same fixed cost f, but have different productivity levels $\varphi > 0$.[2] Given the demand for individual varieties, each firm maximizes its profits by choosing the price of its own variety, which can be expressed as a mark-up over marginal cost: $p(\varphi) = \frac{1}{\rho\varphi}$, where the wage rate is normalized to one. This, in combination with the definition of expenditure from (1), allows us to express firm revenues as:

$$r(\varphi) = R(P\rho\varphi)^{\sigma-1}, \tag{2}$$

which implies that the ratio of any two firms' revenues will only depend on their productivities:

$$\frac{r(\varphi_i)}{r(\varphi_j)} = \left(\frac{\varphi_i}{\varphi_j}\right)^{\sigma-1} \tag{3}$$

Furthermore, firm profits and labor demand can also be expressed as functions of produc-

[2]Thus, each variety ω can be uniquely mapped to a single productivity level φ.

tivity:

$$\pi(\varphi) = \frac{r(\varphi)}{\sigma} - f \tag{4}$$

$$l(\varphi) = f + \frac{\sigma-1}{\sigma} r(\varphi). \tag{5}$$

Entry. There is a large pool of potential entrants into any industry, and prior to entry all the firms are identical. To be able to produce, firms must pay a fixed entry cost $f_e > 0$, which is sunk. After entry, firms draw their productivity φ from a distribution $g(\varphi)$ with a cumulative distribution $G(\varphi)$. If a firm has a low productivity draw upon entry, it may decide to exit immediately and not produce. Firms that decide to produce face an exogenous probability of death δ in each period. Since the productivity level of a firm does not change throughout its lifetime, its optimal per-period profit level remains constant. A firm that enters the market with productivity level φ would then immediately exit if its per-period profits were negative. This scenario implies a zero profit productivity cutoff condition $\pi(\varphi^a) = 0 \iff r(\varphi^a) = \sigma f$, which determines the lowest productivity draw, φ^a, needed for a firm to stay in the market: Any firm with productivity level $\varphi < \varphi^a$ will immediately exit. The productivity distribution of the firms that stay in the market will thus be $\mu(\varphi) = \frac{g(\varphi)}{1-G(\varphi^a)}$, where $1 - G(\varphi^a)$ is the ex ante probability of successful entry. This defines the aggregate productivity level $\tilde{\varphi}$ as a function of the cut-off level φ^a:

$$\tilde{\varphi}(\varphi^a) = \left[\frac{1}{1-G(\varphi^a)} \int_{\varphi^a}^{\infty} \varphi^{\sigma-1} g(\varphi) d\varphi\right]^{\frac{1}{\sigma-1}} \tag{6}$$

As shown in Melitz (2003), $\tilde{\varphi}$ is also the average productivity level for the firms that choose to produce and stay in the market. The combination of equations (4), (5), and the zero profit productivity cutoff condition makes it possible to express average revenues as a function of φ^a:

$$r(\tilde{\varphi}) = \left[\frac{\tilde{\varphi}(\varphi^a)}{\varphi^a}\right]^{\sigma-1} \sigma f. \tag{7}$$

Free entry implies that new firms will enter the market as long as the average profit in the industry is positive. Let M denote the equilibrium number of firms, which ensures that economic profits are competed away.[3] In equilibrium, aggregate variables such as the CES price index P and aggregate expenditure R can be expressed in terms of the equilibrium number of firms and the average productivity:

$$\begin{aligned} P &= M^{\frac{1}{1-\sigma}} p(\tilde{\varphi}) = M^{\frac{1}{1-\sigma}} \frac{1}{\rho\tilde{\varphi}} && (8) \\ R &= Mr(\tilde{\varphi}) && (9) \end{aligned}$$

Equations (7), (8), and (9) allow us to express firm revenues in autarky, previously defined by equation (2), as a function of the zero profit productivity cutoff:

$$r(\varphi) = \sigma f \varphi^{\sigma-1} \left(\frac{1}{\varphi^a} \right)^{\sigma-1}, \tag{10}$$

which, in combination with equation (5), implies that the equilibrium number of workers employed by firm with productivity φ in autarky will be:

$$l_a = f + (\sigma - 1) f \varphi^{\sigma-1} \left(\frac{1}{\varphi^a} \right)^{\sigma-1}. \tag{11}$$

Equation (11) implies that firms with higher productivity will employ more workers. The intuition behind this result is that the more productive firms will enjoy larger market shares and, therefore, will employ more workers in order to satisfy demand.

2.2 Equilibrium under Trade and Protectionism

In this section, we derive the equilibrium number of workers employed in each domestic firm after the domestic economy is opened to trade. The world consists of $n+1 \geq 2$ iden-

[3]See Melitz (2003) for the properties of the equilibrium and details on aggregation.

tical countries.[4] Domestic firms can export their products to any country only after they pay a fixed export cost, $f_x > 0$, in addition to the fixed cost, f, which they must incur to produce domestically. The decision to export is made after each firm draws its productivity level. Regardless of their export status, all domestic firms still incur the same overhead production cost. In addition, exporting firms face higher marginal cost of their exports due to ad valorem tariffs, which are assumed to be symmetric across all trading partners. Thus, each firm's domestic pricing rule is given as before: $p_d(\varphi) = 1/\rho\varphi$, while the export price is: $p_x(\varphi) = (1+t)p_d(\varphi) = (1+t)/\rho\varphi$, where subscript d stands for 'domestic,' and subscript x stands for 'export.' This price rule separability, combined with the assumption that each firm that exports must also engage in domestic production, implies separability of exporting firms' revenues:

$$r(\varphi) = \begin{cases} r_d(\varphi) & \text{if the firm does not export} \\ r_d(\varphi) + nr_x(\varphi) = [1 + (n(1+t))^{1-\sigma}]r_d(\varphi) & \text{if the firm exports to all countries.} \end{cases} \tag{12}$$

In addition, this allows us to decompose each exporting firm's profits into their domestic and foreign portions, $\pi(\varphi) = \pi_d(\varphi) + n\pi_x(\varphi)$, where:

$$\pi_d(\varphi) = \frac{r_d(\varphi)}{\sigma} - f, \;\; \pi_x(\varphi) = \frac{r_x(\varphi)}{\sigma} - f_x. \tag{13}$$

Each exporting firm's labor demand can also be decomposed into its domestic and exporting portions, $l^{ct}(\varphi) = l_d^{ct}(\varphi) + nl_x^{ct}(\varphi)$, where superscript ct denotes 'costly trade' and:

$$l_d^{ct} = f + r_d(\varphi)\frac{\sigma-1}{\sigma}, \;\; l_x^{ct} = f_x + r_x(\varphi)\frac{\sigma-1}{\sigma}. \tag{14}$$

As in the autarky equilibrium, there is a large pool of potential entrants and each firm that enters the market with a productivity level φ would exit immediately if its domestic

[4]This implies that each country has $n \geq 1$ potential trading partners, and all countries share the same wages and same aggregate variables. In the empirical analysis we relax the assumption that the wages are identical.

profits were negative. In addition, however, some firms will also choose to export as long as their productivity draw allows them to realize non-negative profits from exports. This scenario implies two zero-profit productivity cutoff conditions: one for domestic profits, $\pi_d(\varphi^{ct}) = 0$, which determines the lowest productivity draw, φ^{ct}, needed for a firm to stay in business; and one for export profits, $\pi_x(\varphi_x^{ct}) = 0$, which determines the lowest productivity draw, φ_x^{ct}, needed for a firm to export.

The fact that each firm must incur additional fixed costs, f_x, in order to export implies that the lowest productivity draw, φ_x^{ct}, needed for profitable exports is necessarily higher than the lowest productivity threshold, φ^{ct}, needed for domestic production. It is also important to establish the relationship between the zero-profit productivity cutoff in autarky and the two zero-profit productivity cutoffs in the trade equilibrium. As shown in Figure 1, the lowest productivity draw needed for domestic production must be higher once the country opens up to trade.

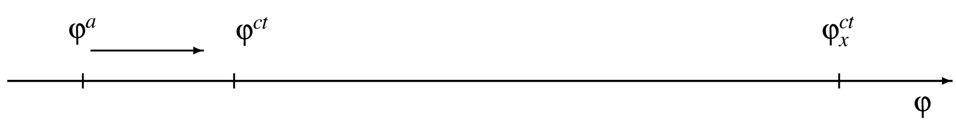

Figure 1: Firm Productivity and Costly Trade

This result is driven by the fact that some domestic firms find it profitable to start exporting, which leads to an increase in their demand for resources. This forces some of the least productive domestic firms out of the market and results in an increase in the average productivity level at home, as well as to an increase in the zero-profit productivity cutoff for domestic production.

Similar to the closed economy case, but this time using the average domestic productivity level $\tilde{\varphi}$ and the average export productivity level $\tilde{\varphi}_x$,[5] we first express average revenues and

[5] Average export productivity is similar to its domestic counterpart, and is equal to $\tilde{\varphi}(\varphi_x^{ct}) = \left[\frac{1}{1-G(\varphi_x^{ct})}\int_{\varphi_x^{ct}}^{\infty} \varphi^{\sigma-1} g(\varphi) d\varphi\right]^{\frac{1}{\sigma-1}}$.

all aggregates in terms of the zero-profit productivity cutoffs, and then use them to solve for the equilibrium number of workers employed in each firm depending on its export status. The labor equation for the firms that only serve the domestic market is very similar to the one describing the autarky equilibrium, the only difference being the zero domestic profit productivity threshold, φ^{ct}, which is higher in the trade equilibrium:

$$l^{ct} = f + (\sigma - 1) f \varphi^{\sigma-1} \left(\frac{1}{\varphi^{ct}} \right)^{\sigma-1}. \tag{15}$$

The equilibrium number of workers employed by an exporting firm is:

$$l^{ct} = f + n f_x + (\sigma - 1) f \varphi^{\sigma-1} \left(\frac{1}{\varphi^{ct}} \right)^{\sigma-1} [1 + n(1+t)]^{1-\sigma}. \tag{16}$$

The intuition for the effects of introducing trade on equilibrium firm-level employment described in equations (15) and (16) is clear. Once a country opens up to trade, the firms that export gain market share due to the fact that they are now producing for other countries as well. The increase in market share for the exporting firms is associated with more hires and an increase in employment. On the other hand, some of the firms that produce only for the domestic economy are forced out of the market while others incur losses associated with layoffs. Given that the change in market share depends on the firm's export status, and hence on the productivity level of the firm, the number of laid-off workers and the number of new hires will be contingent on firm productivity as well.

Taking the difference between the equilibrium number of workers employed in a domestically producing firm in the trade equilibrium, defined in equation (15), and the equilibrium number of workers employed by the same firm in autarky, defined by equation (11), gives an expression for the firm-level layoffs caused by trade. Similarly, the difference between the equilibrium number of workers employed by an exporting firm, defined in equation (16), and the equilibrium number of workers employed by the same firm in autarky, defined by equation (11), defines the number of hires due to trade.[6]

Ideally, one would like to be able to estimate both of the above relationships describing firm-level job destruction and firm-level job creation caused by trade. Empirically this is not possible for two reasons. First, in reality, we very rarely observe regime switching from autarky to trade. What we observe most of the time is trade liberalization. Therefore, in the next section, we derive and discuss the effects of trade liberalization on the labor market, which we then quantify in our empirical analysis. Second, data availability allows us to measure only firm-level layoffs caused by trade as opposed to both trade-induced layoffs and trade-induced hires. To address this issue, we resort to the properties of our theoretical setting. We employ the two zero profit cutoff conditions to express the zero-profit domestic productivity cutoff φ^{ct} in terms of the export productivity cutoff φ_x^{ct} and tariffs:

$$\varphi^{ct} = \varphi_x^{ct} \frac{1}{(1+t^{ct})} \left(\frac{f}{f_x}\right)^{\frac{1}{\sigma-1}}. \tag{17}$$

which allows us to derive a structural equation for the number of workers employed in a domestically producing firm as a function of the zero profit export productivity cutoff and ad valorem tariffs:[7]

$$l^{ct} = f + (\sigma-1) f_x \varphi^{\sigma-1} \left(\frac{1+t^{ct}}{\varphi_x^{ct}}\right)^{\sigma-1}. \tag{18}$$

As will become clear in the next section, equation (18) allows us to quantify the relationship

[6]Technically, the exporting firms should also layoff some workers who are employed in production for the domestic market. As shown in Bernard, Redding and Schott (2007), however, the net effect on employment in the exporting firms will be job creation, while the net effect on employment in the firms that produce only domestically will be job destruction.

[7]For simplicity and clarity of exposition, we only consider lay-offs in domestically producing firms. As noted earlier however, equation (18) also describes employment of workers who are engaged in production for the domestic market in exporting firms. Empirically, this is not a problem since we observe trade-induced layoffs in all firms, regardless of their export status.

between trade liberalization, firm productivity, and trade-induced lay-offs by concentrating on the change in firm-level employment in domestically producing firms.

2.3 Trade Liberalization

In this section, we examine the impact of trade liberalization, in the form of a discrete tariff reduction from t^{ct} to t^{tl}, on productivity and employment levels for domestic firms.[8] Qualitatively, the effects of trade liberalization are identical to the effects of opening up the economy to trade, as described in the previous section. Figure 2 depicts the changes in the zero-profit productivity cutoffs (both domestic and export) in response to trade liberalization.

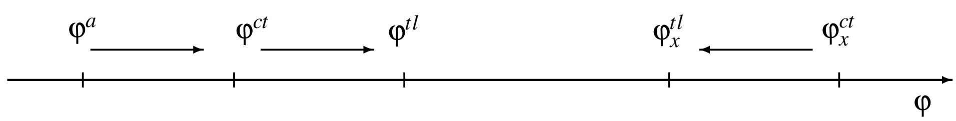

Figure 2: Firm Productivity and Trade Liberalization

The export productivity cutoff decreases from φ_x^{ct} to φ_x^{tl} because, due to lower export costs, firms with lower productivity levels now find it profitable to export, which lowers the minimum productivity threshold required for exporting. Similarly, more foreign firms enter the home market, which forces some of the least productive firms to exit and leads to an increase in the minimum threshold needed for domestic production from φ^{ct} to φ^{tl}.

As discussed earlier, the nature of available data forces us to concentrate on the labor demand for the firms that produce only domestically. In the previous section, we derived a structural equation (equation (16)) for the equilibrium number of workers employed by a domestically producing firm as a function of tariffs. It is possible to show that the equilib-

[8] It should be noted that trade liberalization is symmetric, so that any decrease in domestic protection is matched by an equivalent decrease in foreign protection, with symmetric effects on foreign firms.

rium level of employment for domestic firms after trade liberalization is:

$$l^{tl} \;=\; f+(\sigma-1)f_x\varphi^{\sigma-1}\left(\frac{1+t^{tl}}{\varphi_x^{tl}}\right)^{\sigma-1}. \tag{19}$$

The difference between the number of workers employed by each domestically producing firm before trade liberalization (equation 18) and the number of workers employed by the same firm after trade liberalization (equation 19) defines the number of firm-level layoffs caused by trade liberalization:

$$l^{ct}-l^{tl} \;=\; (\sigma-1)f_x\left(\frac{1+t^{ct}}{\varphi_x^{ct}}\right)^{\sigma-1}\varphi^{\sigma-1}-(\sigma-1)f_x\left(\frac{1+t^{tl}}{\varphi_x^{tl}}\right)^{\sigma-1}\varphi^{\sigma-1}>0. \tag{20}$$

The assumption of trade liberalization, captured by a decrease in tariffs, implies that the expression on right-hand side of equation (20) is strictly positive. Our final step is to make equation (20) econometrically operational by setting the elasticity of substitution to be equal to two, which implies:[9]

$$l^{ct}-l^{tl} \;=\; \frac{f_x}{\varphi_x^{ct}}\left(1+t^{ct}\right)\varphi-\frac{f_x}{\varphi_x^{tl}}\left(1+t^{tl}\right)\varphi \tag{21}$$

Equation (21) allows us to estimate the relation between firm-level trade-induced layoffs, firm-level productivity, and trade liberalization through the coefficients in front of φ, $\varphi(t^{ct}-t^{tl})$ and φt^{tl}. Our expectations about the signs of these coefficients are clear. The expression in brackets in the first term is negative, since the productivity cut-off level for exporting increases with trade liberalization. This suggests that, all else equal, more productive firms that only produce for the domestic market will lay off fewer workers. Trade liberalization is associated with more layoffs for the firms that only produce domestically. Thus, we

[9] We experiment with alternative plausible values for the elasticity of substitution in Appendix A. Our main empirical results do not change, and are available upon request. In addition, in our empirical analysis, we also allow for the elasticity of substitution to vary across industries, which further reinforces our main findings.

expect the second coefficient to be positive. Finally, the negative sign of the third term implies that, all else equal, firms operating in the more protected industries will suffer less unemployment.

We finish this section by further formalizing the relationship between the zero-profit domestic productivity cutoff and the export productivity cutoff in the following proposition:

Proposition 5 *With symmetric trade liberalization, the increase in the zero-profit domestic productivity cutoff is smaller, in absolute value, than the decrease in the export productivity cutoff:*

$$\left|\frac{\varphi^{ct}-\varphi^{tl}}{\varphi^{ct}}\right| < \frac{\varphi_x^{ct}-\varphi_x^{tl}}{\varphi_x^{ct}}.$$

The more a country liberalizes its trade policy, the bigger the difference between the changes in productivity cutoffs.

Proof. Apply the relationship in equation (17) to trade liberalization to show that:

$$\left|\frac{\varphi^{ct}-\varphi^{tl}}{\varphi^{ct}}\right| = \frac{\varphi_x^{ct}-\varphi_x^{tl}\frac{1+t^{ct}}{1+t^{tl}}}{\varphi_x^{ct}} \tag{22}$$

Trade liberalization, measured by reduction in tariffs, implies $\frac{1+t^{ct}}{1+t^{tl}} > 1$, which means that $\varphi_x^{tl}\frac{1+t^{ct}}{1+t^{tl}} > \varphi_x^{tl}$ and, therefore, $\frac{\varphi_x^{ct}-\varphi_x^{tl}\frac{1+t^{ct}}{1+t^{tl}}}{\varphi_x^{ct}} = \left|\frac{\varphi^{ct}-\varphi^{tl}}{\varphi^{ct}}\right| < \frac{\varphi_x^{ct}-\varphi_x^{tl}}{\varphi_x^{ct}}$.

Intuitionally, the lower magnitude if the increase in the zero-profit productivity cut-off can be explained with the secondary nature of the effect on the firms that produce only domestically. The direct effect of trade liberalization falls on the exporting side of the market where more firms can afford to bear the sunk cost of exporting and, therefore, the zero-profit export cut-off falls as a direct result of trade liberalization. The increase in the zero-profit cut-off for the domestically producing firms is caused by the fact that resource prices are bid up by the exporters and that forces some of the less productive firms to leave the market.

3 Empirical Analysis

We start this section by specifying the estimation equation and describing the data employed in our analysis. Next, we present and interpret our results to provide empirical support for the theoretical predictions derived in the previous section. Sensitivity checks confirm the robustness of our results.

3.1 Estimation Approach

To quantify the relationship between firm productivity, trade, trade liberalization, and firm-level job destruction, we translate the structural labor equation for firm i operating in industry j, $i \in j$:

$$l_i^{ct} - l_i^{tl} = f_x \left[\frac{1}{\varphi_x^{ct}} - \frac{1}{\varphi_x^{tl}} \right] \varphi_i + \frac{f_x}{\varphi_x^{ct}} \varphi_i \left(t_j^{ct} - t_j^{tl} \right) + f_x \left[\frac{1}{\varphi_x^{ct}} - \frac{1}{\varphi_x^{tl}} \right] \varphi_i t_j^{tl}, \qquad (23)$$

into the following estimation equation:

$$UNEMPL_i = \alpha_0 + \alpha_1 TFP_i + \alpha_2 LIB_j * TFP_i + \alpha_3 T_j * TFP_i + \varepsilon_{ij}, \qquad (24)$$

where $UNEMPL_i = ln(l_i^{ct} - l_i^{tl})$ is the logarithm of the number of workers who were laid off from firm i due to import competition, $TFP_i = \varphi_i$ is the logarithm of total factor productivity of firm i, T_j is the ad-valorem tariff faced by the international competitors of import-competing firm i operating in industry j, LIB_j is the difference between the lagged and current ad-valorem tariffs in industry j, which is a proxy for the magnitude of liberalization, and $\alpha_1 = f_x \left[\frac{1}{\varphi_x^{ct}} - \frac{1}{\varphi_x^{tl}} \right]$, $\alpha_2 = \frac{f_x}{\varphi_x^{ct}}$, and $\alpha_3 = f_x \left[\frac{1}{\varphi_x^{ct}} - \frac{1}{\varphi_x^{tl}} \right]$. Since f_x and each of the export productivity thresholds are positive, and the export productivity threshold decreases with trade liberalization, we form the following expectations about the estimates of the coefficients in equation (24): The coefficient in front of TFP_i, α_1, should be negative implying an inverse relationship between total factor productivity and the number of workers laid-off by each import-competing firm due to trade. The estimate of α_2 should be positive, implying a positive relationship between the interaction of liberalization and productivity ($LIB_j * TFP_i$): all else equal, the more open the country is, the more layoffs there will be in the domestically producing firms. Finally, theory predicts a negative sign of the coefficient on the interaction between tariffs and TFP, α_3, which implies that, all else equal, domestically producing firms in the more protected industries will lay off less workers.

The fact that we are investigating the effect of trade liberalization on unemployment only for the firms that suffer from trade implies that our results are subject to selection bias due to the fact that the firms in our sample are selected in a non-random manner. To address this problem, we follow (Heckman 1979) and set up the following econometric model:

$$UNEMPL_i = \alpha_0 + \alpha_1 TFP_i + \alpha_2 LIB_j * TFP_i + \alpha_3 T_j * TFP_i + \varepsilon_{1ij} \quad (25)$$

and unemployment is observed if:

$$\beta_0 + \beta_1 EXCL_i + \beta \mathbf{X_{ij}} + \varepsilon_{2ij} > 0, \quad (26)$$

where ε_{1ij} and ε_{2ij} are correlated and normally distributed. Equation (26) is our selection equation based on whether a firm suffers from trade or not, ($EXCL_i$) as our exclusionary variable, and $\mathbf{X_{ij}}$ is a set of control variables, which will be described below.

Because selection is heavily present in our model, finding a good exclusionary variable is crucial for sound econometric results. Fortunately, a closer look at the Petition for Trade Adjustment Assistance data, which we use to measure firm-level trade-induced unemployment, gave us an excellent opportunity to construct a good exclusion variable. In order to receive TAA, US firms must go through a formal process of certification, where the government determines whether the firm is really affected by trade or it suffers for any other reason. One would expect that if two firms produce identical products and one of them has been TAA-certified, the other will also be eligible to enter the program. Surprisingly this is not the case. There were cases in the data when even branches of the same company, producing identical products but operating in different states, had different outcomes when applying for TAA. This made us think that overall political affiliation of a given state might be a good indicator of what firm's chances of getting TAA were. At the same time, whether a state is "blue" or "red" should not be related to any firm's performance and trade-induced unemployment, in particular. Thus, we identified the political orientation of the state for each firm in our sample based on the electoral results in 2000 and used it as an exclusionary variable in our selection model.

3.2 Data Description

An advantage of our data is that it allows us to identify the *trade-induced* losses, in terms of layoffs, at the firm level. We use the Petition for Trade Adjustment Assistance Database (PTAA), a data set constructed and maintained by the Employment and Training Administration of the U.S. Department of Labor, to construct our trade-induced unemployment variable. The PTAA data consists of firm-level data series at the 4-digit Standard Industrial Classification (SIC) level including the date when a petition for TAA was filed, when and whether the petition was certified, and the estimated number of workers to be laid off by each firm as a consequence of increase in the quantity of imports for the industry. We construct trade-induced unemployment by first dropping all firms whose petitions were not certified for TAA, and then summing the total number of workers who were laid off due to trade, and therefore TAA certified, for each firm and year. After that, to calculate labor costs, we follow Keller and Yeaple (2007), and multiply the number of employees in each firm (data item 29 in Compustat) by the average industry wage from the Annual Survey of Manufactures (ASM) for the corresponding year.

To calculate total factor firm productivity, the main explanatory variable in our estimation, we follow the procedure described in Keller and Yeaple (2007), who adopt the methodology from Olley and Pakes (1996).[10] The latter study emphasizes the simultaneity problem

[10]See Appendix A for details on the TFP calculation procedure.

and selection bias for the calculation of productivity and allows for inter-industry TFP comparisons. Once we calculate total factor productivity for each firm, we merge these data with the certified firms from the TAA data set, which determines the size of the estimation sample for our main analysis to be 1738 firm-level observations.

In addition to firm-level data on layoffs and productivity, we also employ various trade variables at the industry level, including imports, exports, and tariffs. We use tariff data to test our theoretical predictions about trade liberalization. Even though non-tariff trade barriers (NTBs) are probably a more significant and relevant measure of protection, we use tariffs for two reasons. First, comprehensive data on NTBs for the period of investigation are not available. Second, we believe that U.S. tariffs, which, for the period of interest in this paper, are determined under the regulations and rules of the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO), are the more appropriate measure of protection in the current theoretical setting, which assumes symmetric trade costs and symmetric trade liberalization. Therefore, we employ the change in tariffs to measure trade liberalization.[11] We use two sources for data on tariffs. Import-weighted average tariffs for the period 1980-1988 are from Bernard, Jensen and Schott (2006) and the tariffs for the years after 1989 are from the Trade Analysis Information System (TRAINS).[12]

Data on sectoral imports and exports classified according to the four-digit SIC 1972-basis are taken from two sources. Data on imports up to 1989 are from Feenstra (1996) and data on exports up to 1990 are from Feenstra (1997). Trade flows for the years after 1990 (1989 for imports) are from the United Nations Conference on Trade and Development (UNCTAD) and TRAINS.

[11] In order to keep our sample size as large as possible, we use tariffs at the three-digit SIC level to obtain our main estimation results. In the sensitivity analysis, we also experiment with tariffs at the four-digit SIC level and obtain very similar estimates.

[12] We accessed TRAINS through the World Bank's World Integrated Trade Solution (WITS) software at http://wits.worldbank.org/witsweb/.

3.3 Empirical Findings and Quantitative Implications

Results from the estimation of alternative specifications of equation (24) are presented in Table 1. Column 1 of the table reports estimation results obtained from regressing trade-induced, firm-level unemployment on firm-level total factor productivity only. As can be seen from the table, there is a negative and significant relationship between TFP and trade-induced firm-level layoffs. Or preliminary results suggest that a 1% increase in productivity will lower trade-induced layoffs by about 14%.

Next, we estimate the full structural equation (24). Results, reported in column 2, are as expected: the negative and significant coefficient on TFP indicates an inverse relationship between total firm productivity and trade-induced firm level job destruction, which is in accordance with theory. It should be noted that we cannot interpret the coefficient on TFP directly as the effect of productivity on layoffs since TFP enters interactively in the other terms in our model. We decompose and analyze the TFP effect below. We also establish a positive and significant relationship between the degree of trade liberalization interacted with TFP and trade-induced unemployment. As expected, the positive coefficient on LIB implies that, all else equal, the more a country opens up to trade the more layoffs there will be in import-competing industries and firms. Finally, we do not find support for the prediction that, all else equal, more protected industries will lay off fewer workers. This can be seen from the insignificant coefficient on T*TFP.

Our theoretical setting assumes that wages are equal across different firms. However, that is not the case in reality. Therefore, we control for different wages by including labor costs as a regressor in our empirical model. We calculate labor costs as the product of the number of employees in each firm (from Compustat) and the average industry wage (from the Annual Survey of Manufactures) for the corresponding year. Column 3 of Table 1 reports our results. Once again, we establish a negative and significant relationship between firm productivity and trade-induced layoffs. The coefficient on the interaction between productivity and trade liberalization is also significant and has the expected positive sign. Once again,

Table 1: Firm Productivity and Trade Liberalization

	(1) TFP	(2) Model	(3) Labor	(4) Sigma	(5) Polit	(6) Selection
TFP	-0.140	-0.147	-0.185	-0.183	-0.181	-0.352
	(0.074)+	(0.070)*	(0.094)*	(0.075)*	(0.081)*	(0.094)**
LIB*TFP		1.781	1.924	1.968	1.903	1.230
		(0.857)*	(0.796)*	(0.653)**	(0.872)*	(0.595)*
T*TFP		0.002	0.325	0.327	0.278	0.749
		(0.517)	(0.485)	(0.608)	(0.492)	(0.500)
LABOR_COST			0.0002	0.0002	0.0002	0.0002
			(0.000)**	(0.000)**	(0.000)**	(0.000)**
SIGMA				0.046	0.049	0.160
				(0.021)*	(0.021)*	(0.031)**
POLIT					0.167	
					(0.120)	
Constant	4.688	4.682	4.578	4.329	4.253	5.525
	(0.211)**	(0.194)**	(0.264)**	(0.220)**	(0.244)**	(0.332)**
SELECTION						
POLIT						0.099
						(0.041)*
TFP						0.112
						(0.042)**
CH NET TRADE						-0.0002
						(0.000)*
LABOR_COST						-0.000
						(0.000)
SIGMA						-0.066
						(0.012)**
Constant						0.211
						(0.146)
χ^2						71.295
λ						-2.120
						(0.093)
TFP		-.138	-.166	-.163	-.163	-.323
		(.066)*	(.089) +	(.069)*	(.078)*	(.113)**
Observations	1150	1150	1150	1025	1025	1738

Standard errors in parentheses

+ $p < 0.10$, * $p < .05$, ** $p < .01$

the relationship between current tariffs and layoffs due to trade is not significant. Finally, as expected, labor costs have a positive and significant effect on firm layoffs, which should not be surprising with downward-sloping labor demand: the more costly labor is, the more workers are laid off.

Another simplification in our theoretical model is the assumption of a constant elasticity of substitution across sectors and goods. While convenient, such a simplification means we cannot investigate the relationship between an important source of industry variation, such as the elasticity of substitution, and trade-induced layoffs. Therefore, our next step is to control for the variation of σ across sectors by adding it as a covariate in our estimation model. Data on industries' elasticities of substitution comes from (Broda and Weinstein 2006). Column 4 of Table 1 presents our results, which are very similar to those ones obtained after controlling for labor costs. As expected, the new variable, SIGMA, is significant. The positive sign on the coefficient on the elasticity variable is also expected and implies that, all else equal, firms in sectors with a higher elasticity of substitution will suffer more layoffs.

Next, we estimate the selection model (25)-(26), which we consider to be our most comprehensive specification. In order to do so, we construct an exclusionary variable, POLIT, which takes a value of one if a state is classified as Republican, based on the electoral votes cast during a given presidential election year. First, we check whether our exclusionary variable has any explanatory power in the structural equation 25. As can be seen from column 5, we find no relation between the political affiliation of a state and the number of workers laid off due to trade from a firm operating in this state. In addition, the signs, the significance, and the magnitude of the other explanatory variables do not change. Overall, these results suggest that POLIT might be a good exclusionary variable for our selection model.

We employ maximum likelihood estimation (MLE) and the Heckman selection model (25)-(26) to obtain our main estimates reported in the last column of Table 1.[13] In addition to

[13] We also experiment with clustered standard errors to control for industry-year effects and with a jacknife

our exclusionary variable POLIT, we use other covariates in the selection equation, which we believe may affect TAA certification, including: firm productivity, change in net trade (increase in exports minus increase in imports), labor cost, and elasticity of substitution. As can be seen from the results presented in column 6, the coefficient on POLIT is significant, which, in combination with a Wald test ($\chi^2_1 = 71.295$) reported at the bottom of column 6, validates our selection model. The positive sign of the coefficient on POLIT implies that, all else equal, it is more likely to become TAA-certified in a Republican state.[14] The positive sign of TFP in our selection equation suggests that more productive firms are more likely to receive TAA. The fact that the change in net trade has a negative effect on the likelihood of qualifying for TAA should not be surprising since 'increase in imports' is one of the key criteria used in the TAA certification process. Finally, we find that firms that have higher elasticity of substitution are less likely to become TAA-certified. Estimation results obtained for the structural equation after controlling for selection are qualitatively similar to the results presented in column 2. The coefficient on TFP is negative and significant; the coefficient on the interaction between trade liberalization and TFP is positive and significant; and, the coefficient on T*TFP is still not significant. The main difference lies in the magnitude on the TFP coefficient, which is now twice as large, and in the increase in the significance of TFP. These results indicate an upward bias in the effect of productivity on layoffs when we do not control for selection.

Our estimates allow us to quantify the net effect of productivity on trade-induced layoffs. To do so, we use average tariffs and average lagged tariffs and calculate:

$$\frac{\partial UNEMPL}{\partial \overline{TFP}} = \alpha_1 + \alpha_2 \overline{LIB} + \alpha_3 \overline{T} \tag{27}$$

Employing the coefficients from column 6 of Table 1, which we believe are the most ap-

procedure to correct for outliers. In each case, our results, available upon request, are very similar to the main estimates in Table 1.

[14]This, by itself, is a very interesting finding, which we investigate more thoroughly in a separate paper.

propriate, we calculate the effect of productivity on trade-induced layoffs to be negative, significant, and equal to -0.32 with a standard error 0.113. This means that, all else equal, a one percent increase in the level of total factor firm productivity will lower the number of workers who are laid off by each firm because of trade liberalization by 32 percent. As can be seen from Table 1, other specifications give similar results for the negative relations between TFP and trade-induced layoffs. Our estimates of these effects, presented at the bottom of the table, range between 14 percent and 32 percent.

We are also able to quantify the effect of trade liberalization on trade-induced, firm-level layoffs. Since our trade liberalization variable enters the estimation equation in levels, while the layoffs are measured in logs, to calculate the elasticity of trade-induced layoffs with respect to trade liberalization, we multiply the coefficient in front of the interaction term LIB*TFP by the means of the TFP and LIB variables.[15] We find that a one percent increase in trade liberalization results in a significant increase of 2% with standard error of 0.009 in firm-level layoffs caused by trade.

The coefficients from column 6 do not allow us to recover directly the structural parameters φ_x^{ct} and φ_x^{tl}, which correspond to the productivity cutoffs for the exporting firms before and after trade liberalization. However, under the assumption that our theoretical model is a true representation of the data, we can draw some important inferences on the direction and magnitude of the changes not only in the export productivity cutoffs, but also in the domestic productivity cutoffs. The negative and significant coefficient on TFP implies that the export productivity cutoff before trade liberalization is higher than the corresponding cutoff after trade liberalization, which is exactly what theory predicts. To see this one should examine at the theoretical expression of the TFP coefficient as $\alpha_1 = f_x\left[\frac{1}{\varphi_x^{ct}} - \frac{1}{\varphi_x^{tl}}\right]$. Our estimate of α_1 is below zero, which implies that φ_x^{ct} is greater than φ_x^{tl}. Using the relation between domestic productivity cutoffs, tariffs, and export productivity cutoffs described in equation (22), we show that the zero-profit productivity cutoff before trade liberalization is

[15] In general, in a log-linear model, the regression equation is $lnY = a + bX + \varepsilon$, and the slope coefficient is $dlnY/dX = (dY/dX)/Y$. In order to calculate the elasticity, the coefficient is multiplied by X.

lower than the zero-profit productivity cutoff after trade liberalization.

Employing the coefficients on TFP and LIB*TFP from equation (24), we calculate and compare the percentage changes in the export and the domestic zero-profit productivity cutoffs. First, we express the decrease in the export productivity cutoff, in terms of our estimated coefficients, as:

$$\frac{\varphi_x^{ct} - \varphi_x^{tl}}{\varphi_x^{ct}} = \frac{\alpha_1}{\alpha_1 - \alpha_2}. \tag{28}$$

Applying the delta method we find the above relationship to be significant. We estimate that trade liberalisation results in a 22% with a standard error of 0.092 decrease in the export productivity threshold. In order to estimate the increase in the domestic zero-profit productivity cut-off, we employ equation (28) in combination with equation (22), given the average tariffs before and after trade liberalization. We find the increase in the domestic zero-profit productivity cut-off to be significant and equal to 17% with a standard error of 0.076. The 5% difference between the changes in the export productivity and domestic productivity cut-offs is significantly different from zero at any significance level, and is in accordance with the theoretical prediction of Proposition 1.

3.4 Sensitivity Analysis

We start our sensitivity analysis by introducing control variables which we believe are important determinants of the magnitude of firm-level job destruction when a country liberalizes its trade policy. Potential candidates are the level of imports and exports. The intuition for controlling for imports is clear: the more an industry is exposed to foreign competition, the more workers in this industry are likely to lose their jobs due to trade. We include exports because we expect that, all else equal, fewer jobs will be lost in industries with larger exports. OLS estimates are presented in column 1 of Table 2, while results in column 2 of the table are from a Heckman selection model.

Both sets of results are very similar to our main results. We find a significant and negative impact of firm level productivity on layoffs. The coefficient on the interaction term

LIB*TFP is positive and significant as expected. Once again, the coefficient on the other interaction term T*TFP, is not significant and does not have the expected sign. In line with our expectations and previous results, higher labor costs imply an increase in trade-induced layoffs and an increase in the elasticity of substitution is positively associated with layoffs. The positive and significant coefficient on IMPORTS implies that, all else equal, an increase in sectoral imports is associated with an increase in firm-level layoffs. Finally, the inverse relation between an increase in exports and trade-induced layoffs is captured by the negative and significant coefficient on EXPORTS.

Next, we turn to trade liberalization and tariffs. To obtain our main estimation results, we employ tariffs at the three-digit SIC level. Here, we experiment with tariffs at the four-digit SIC level. Arguably, four-digit SIC tariffs are a better measure of protection for our purposes as we want to work with data at a disaggregation level which is as close as possible to the firm level. We obtain two sets of estimation results: first using our main selection model, (column 3 of Table 2), and then after controlling for exports and imports in column 4. Once again, both sets of results are very similar to our previous findings: The coefficients of TFP and LIB*TFP are significant and have the expected signs; but the coefficient on T*TFP still does not have the expected negative sign and is not significant; the coefficients on LABOR_COST and SIGMA are positive and significant. Finally, there is a positive and significant relation between IMPORTS and layoffs, and a negative and significant relation between EXPORTS and layoffs.

4 Conclusion

In this paper, we attempted to reconcile the vast amount of theoretical literature devoted to studying the interactions between firm productivity, trade, and trade liberalization, and the lack of empirical evidence for these relationships, especially when labor markets are in question. The main contributions of our work are twofold: first, concentrating on the labor market we use reliable data that enables us to measure firm-level unemployment caused by trade, and employ a selection model to quantify the relationships between productivity, trade liberalization, and trade-induced layoffs. More specifically, we find that a one percent increase in total factor firm productivity decreases trade-induced layoffs by 32%, while an additional percent of trade liberalization increases the number of firm-level, trade-induced layoffs by 2%. Second, we provide empirical evidence for key theoretical predictions from previous studies regarding the direction and magnitude of the changes in the minimum productivity thresholds required for domestic production as well as exports. In particular, our results suggest that the zero-profit productivity cutoff for domestic firms will increase while the export productivity cutoff will fall as consequences of trade liberalization. In addition, we show that, in absolute terms, the change in the zero-profit productivity cutoff for domestic production will be larger than the change in the export productivity cutoff.

An interesting extension of this paper will be to test whether and how our findings differ for industries with comparative advantage as opposed to industries with comparative disadvantage. Bernard *et al.* (2007) extend Melitz's (2003) model by allowing for firm heterogeneity in a comparative advantage setting. They show that the zero-profit productivity cutoff increases in both types of industries but the increase is bigger in the sectors with comparative advantage. In addition, the export productivity cutoff is closer to the zero-profit productivity cutoff in sectors with comparative advantage. With regard to the labor market, their findings suggest that trade liberalization results in simultaneous job creation and job destruction in all industries, but the comparative disadvantage industries exhibit net job destruction while comparative advantage industries experience net job creation. In accordance with their predictions, simple descriptive statistics of our data indicate that trade-induced job destruction is observed in each industry in our sample, regardless of whether the sector has a comparative advantage or not. After identifying the sectors with and without comparative advantage, our data will allow for direct testing of whether the effects of trade liberalization on the productivity cutoffs are contingent on the type of the industry.

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Table 2: Sensitivity Analysis

	(1) No Sel-Cont	(2) Cont	(3) SIC4	(4) SIC4-Cont
TFP	-0.159	-0.327	-0.340	-0.311
	(0.077)*	(0.098)**	(0.085)**	(0.106)**
LIB*TFP	2.262	1.498	1.068	1.267
	(0.760)**	(0.717)*	(0.534)*	(0.600)*
T*TFP	0.013	0.431	0.664	0.284
	(0.548)	(0.700)	(0.447)	(0.505)
LABOR_COST	0.0002	0.0002	0.0002	0.0002
	(0.000)**	(0.000)**	(0.000)**	(0.000)**
SIGMA	0.039	0.150	0.170	0.160
	(0.020)*	(0.042)**	(0.023)**	(0.041)**
IMPORTS	0.255	0.166		0.160
	(0.042)**	(0.051)**		(0.052)**
EXPORTS	-0.383	-0.260		-0.265
	(0.090)**	(0.094)**		(0.093)**
Constant	4.248	5.460	5.498	5.457
	(0.210)**	(0.426)**	(0.276)**	(0.443)**
SELECTION				
POLIT		0.084	0.103	0.091
		(0.048)+	(0.041)*	(0.045)*
TFP		0.111	0.103	0.101
		(0.044)*	(0.042)*	(0.042)*
CH NET TRADE		-0.0001	-0.0002	-0.0001
		(0.000)+	(0.000)**	(0.000)*
LABOR_COST		-0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)
SIGMA		-0.067	-0.070	-0.071
		(0.015)**	(0.011)**	(0.013)**
Constant		0.234	0.214	0.237
		(0.149)	(0.148)	(0.149)
χ^2		49.833	63.650	44.961
λ		-2.050	-2.113	-2.043
		(0.098)	(0.099)	(0.105)
TFP	-.147	-.307	-.315	-.297
	(0.073)*	(.091)**	(0.082)**	(0.099)**
Observations	1025	1738	1678	1678

Standard errors in parentheses

+ $p < 0.10$, * $p < .05$, ** $p < .01$

Appendix A: Alternative Specification of σ

To obtain our main estimation results, we work with the simplest form of our structural labor equation by setting the elasticity of substitution equal to two. Here, we formally expand the polynomial defined in equation (18). Starting with the original equation (18),

$$l_i^{ct} - l_i^{tl} = (\sigma-1) f_x \varphi_i^{\sigma-1} \left[\left(\frac{1+t^{ct}}{\varphi_x^{ct}} \right)^{\sigma-1} - \left(\frac{1+t^{tl}}{\varphi_x^{tl}} \right)^{\sigma-1} \right], \tag{29}$$

we can show that for reasonable values of σ, it takes the following forms:

$$l_i^{ct} - l_i^{tl} = \begin{cases} f_x \left[\frac{1}{\varphi_x^{ct}} - \frac{1}{\varphi_x^{tl}} \right] \varphi_i + \frac{f_x}{\varphi_x^{ct}} \varphi_i t^{ct} - \frac{f_x}{\varphi_x^{tl}} \varphi_i t^{tl}, & \sigma = 2 \\ f_x \left[\frac{1}{(\varphi_x^{ct})^2} - \frac{1}{(\varphi_x^{tl})^2} \right] \varphi_i^2 + \frac{f_x}{(\varphi_x^{ct})^2} \varphi_i^2 t^{ct} + \frac{f_x}{(\varphi_x^{ct})^2} \varphi_i^2 (t^{ct})^2 & \\ - \frac{f_x}{(\varphi_x^{tl})^2} \varphi_i^2 t^{tl} - \frac{f_x}{(\varphi_x^{tl})^2} \varphi_i^2 (t^{tl})^2, & \sigma = 3 \\ f_x \left[\frac{1}{(\varphi_x^{ct})^3} - \frac{1}{(\varphi_x^{tl})^3} \right] \varphi_i^3 + \frac{f_x}{(\varphi_x^{ct})^3} \varphi_i^3 t^{ct} + \frac{f_x}{(\varphi_x^{ct})^3} \varphi_i^3 (t^{ct})^2 + \frac{f_x}{(\varphi_x^{ct})^3} \varphi_i^3 (t^{ct})^3 & \\ - \frac{f_x}{(\varphi_x^{tl})^3} \varphi_i^3 t^{tl} - \frac{f_x}{(\varphi_x^{tl})^3} \varphi_i^3 (t^{tl})^2 - \frac{f_x}{(\varphi_x^{tl})^3} \varphi_i^3 (t^{tl})^3, & \sigma = 4 \\ \quad . \quad . \quad . & \sigma \in \{5,6,7\} \end{cases}$$

We estimate the above equations, derived for different values of σ, to find that the new estimates (available upon request), are very similar to the main results reported in Table 1 and the sensitivity analysis presented in Table 2.

Appendix B: TFP Calculation Procedure

Consider the following production function that assumes Cobb Douglas technology:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_m m_{it} + \beta_k k_{it} + u_{it}, \tag{30}$$

where y_{it} is the logarithm of the firm i's output at time t, while l_{it}, m_{it} and k_{it} represent the firm i's (logarithm of) labor, materials and capital inputs respectively. Let the error term u_{it} be composed of two parts,

$$u_{it} = \omega_{it} + \eta_{it}, \tag{31}$$

The simultaneity problem here is that a part of the productivity, ω_{it}, will be observed by the firm and will affect its decision of the factor inputs such as labor or materials. Hence, the error term and the regressors will be correlated and OLS estimation will give biased results.

Selection bias arises because some of the firms stop producing and exit the market in a non-random manner. This could be the case when firms with higher levels of capital are less likely to exit the market if they receive a low realization of ω_{it}. Given that small firms might exit at productivity draws for which large firms would keep operating, the correlation between ω_{it} and k_{it} is negative. Failing to control for this self-selection will cause a negative bias in the capital coefficient. However, given our data set, we do not have firms that exit the market during the time period analyzed and hence we do not correct for this bias.

Following previous empirical work, we assume that labor and materials are variable inputs, so they are contemporaneously correlated with ω_{it}. However, capital k_{it} is determined by past values of ω, not the current one. Investment is then a strictly increasing function of ω_{it} and k_{it}, and provided that $i_{it} > 0$, it can be inverted to get an expression for the productivity ω_{it}:

$$\omega_{it} = h_{it}(i_{it}, k_{it}) \tag{32}$$

Substituting (32) into (30) will give us:

$$y_{it} = \beta_l l_{it} + \beta_m m_{it} + \phi_{it}(i_{it}, k_{it}) + \eta_{it}, \tag{33}$$

where $\phi_{it}(i_{it}, k_{it}) = \beta_0 + \beta_k k_{it} + h_{it}(i_{it}, k_{it})$, and can be estimated by a fourth order polynomial in k_{it} and i_{it}. In the first step, we estimate the equation (33) and get consistent estimates for β_l and β_m. Then, in order to identify β_k, we assume ω_{it} is a random walk i.e., $\xi_{it} = \omega_{it} - \omega_{it-1}$ and estimate the following equation:

$$y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_m m_{it} = \beta_k k_{it} + g(\hat{\phi}_{it-1} - \beta_k k_{it-1}) + \xi_{it} + \eta_{it}, \tag{34}$$

where $\hat{\phi}_{it-1}$ is estimated from (33), $\hat{\phi}_{it-1} - \beta_k k_{it-1}$ is an estimate of ω_{it-1} and the unknown function $g(.)$ is a fourth order polynomial in $\hat{\phi}_{it-1} - \beta_k k_{it-1}$ and $\hat{P}_{it}$. After estimating equation (33), we estimate log total factor productivity as:

$$tfp_{it} = y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_m m_{it} - \hat{\beta}_k k_{it} \tag{35}$$

Data on firm level output, labor, materials and capital, needed to calculate firm productivity, are taken from Standard & Poor's Compustat Industrial Database. Output is measured as the value of nominal net sales (data item 12 in Compustat), which we deflate by using value added price deflators from the Bureau of Economic Analysis (BEA) at the two-digit NAICS. The nominal value of expenditures on materials is calculated by subtracting capital depreciation and amortization (data item 14 in Compustat) and labor costs from the total cost of goods sold (data item 41) and selling, general, and administrative expenses (data item 189 in Compustat). We deflate the nominal material costs by the two-digit NAICS industry material price deflators from the BEA and Bartelsman, Becker, and Gray (2001). Labor costs are calculated as the product of the number of employees in each firm (data item 29 in Compustat) and the average industry wage, from the Annual Survey of Manufactures (ASM) for the corresponding year. Capital (data item 8 in Compustat) is defined as the value of property, plant and equipment net of depreciation. To deflate this variable we use the two-digit NAICS industry investment price deflators from the BEA and Bartelsman, Becker, and Gray (2001). Finally, we use the same deflators to adjust the nominal value of investment from Compustat.

Do Audit Fees Influence Credit Risk and Asymmetric Information Problems? Evidence from the Syndicated Loan Market

Doctoral Dissertation Chapter 3

Pinar Uysal

Department of Economics

Boston College

Chestnut Hill, MA

August, 2009

This paper is based on joint work with Lewis W. Gaul, Financial Economist, Office of the Comptroller of the Currency

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1 Introduction

Several studies suggest that audited financial statements influence the terms and structure of syndicated loans. However, there is little or no research examining the influence of *potential* financial statement errors.[1,2] Previous research suggests that in the syndicated loan market, a greater likelihood of potential accounting errors increases asymmetric information problems and increases borrowers' credit risk (Graham, Li and Qiu 2007). In addition, Dye (1993) and Simunic (1980) suggest that total equilibrium auditing fees may be related to the likelihood of potential accounting errors.[3] In this paper, we examine whether an increase in equilibrium audit fees as the result of an increase in the demand for auditing services is related to credit risk and asymmetric information problems in the syndicated loan market. We suggest that an increase in demand for auditing services should be associated with a greater quantity (hours billed) and/or price (hourly fee) of auditing services purchased in equilibrium, resulting in greater total audit fees.[4] We speculate that the extent of borrowers' credit risk and asymmetric information problems is decreasing in the quantity of auditing services purchased.[5] We use data on auditing fees and syndicated loans to provide evidence that an increase in auditing fees, due to an increase in the demand for

[1] A syndicated loan is a loan where two or more lenders provide a loan to a borrower. Typically, a lead lender negotiates the terms of a loan contract directly with a borrower for an agreed-upon range of interest rates. The lead lender then uses the negotiated terms of the loan contract to solicit participant lenders to provide a portion of the loan's funding. Usually, a lead lender provides funding for the residual portion of the loan that remains after soliciting financing from participants. Lead lenders typically transfer as much ownership of loans to participants as possible.

[2] Recent research describing how audited financial statements potentially reduce asymmetric information problems in the syndicated loan market include Simons (1993), Preece and Mullineaux (1996), Dennis and Mullineaux (2000), Jones, Lang and Nigro (2000), Lee and Mullineaux (2004), Panyagometh and Roberts (2002), Esty and Megginson (2003), and Sufi (2007).

[3] For the remainder of the paper we refer to audit fees as the price multiplied by the quantity of auditing services. When needed, we refer to the price and quantity of auditing services separately. Consistent with Bell, Landsman and Shackelford (2001), we interpret the unit of audit quantity as hours of auditing services, and the price of auditing services as the fee per hour of auditing services.

[4] We define the quantity of auditing services as the number of hours billed by auditors and price of auditing services as the hourly fee charged by auditors.

[5] Auditors reduce credit risk and asymmetric information problems by providing a certain level of assurance that financial records are free from a material error. We suggest that the level of assurance auditors provide is an increasing function of the number of auditing hours billed.

auditing services, is negatively associated with the interest rates and the maturity length of syndicated loans.[6] In addition, we find that total audit fees are positively associated with the number of lenders in syndicated loans; however, we are unable to discern whether this result is due to movements in the supply or demand curves for auditing services. We identify an increase in the demand for auditing services through an instrumental variable procedure with instruments that are expected to shift the demand curve for auditing services rather than the supply curve for auditing services. We argue that our results are consistent with the argument that an increase in the demand for auditing services is associated with a decline in credit risk and asymmetric information problems in the syndicated loan market due to a decrease in the likelihood of potential accounting errors.

In the syndicated loan market, potential accounting errors exacerbate credit risk and asymmetric information problems. A greater likelihood of potential accounting errors reduces borrowers' expected future profitability thereby increasing borrowers' credit risk.[7] In addition, since borrowers are likely to have better information regarding their own characteristics compared to what would even be presented in the most accurate financial statements, potential accounting errors increase asymmetric information problems between borrowers and lenders. The Securities Exchange Act of 1934 mandates that all publicly traded firms

[6]While it may seem controversial that firms with greater credit quality and fewer asymmetric information problems would borrow at shorter maturities, several empirical papers find similar results with similar data sets. For example, Strahan (1999) finds that borrowers with speculative grade debt ratings borrow at higher interest rates and longer maturities in the syndicated loan market. Moreover, Graham, Li and Qiu (2007) examines the impact of realized accounting errors and finds firms with realized accounting errors borrow at shorter maturities because they are of intermediate to high risk. As we more fully articulate later on, we predict that the majority of our borrowers in our data sample are of moderate to high credit quality, which we will assert allows us to predict maturity is negatively associated with credit quality and asymmetric information problems. In addition, Graham, Li and Qiu (2007) mentions the same point we make later on, that maturity is a non-monotonic function of credit quality. We mention this all early on, to be proactive in justifying this possibly counterintuitive prediction to readers.

[7]Graham, Li and Qiu (2007) suggests that when accounting errors are realized, firms' expected future profitability can decline for three reasons: (1) usually revealing accounting errors unveils unfavorable information regarding firms' expected future profitability; (2) firms typically have to pay damages to investors that have been misled by accounting errors; (3) the terms of trade firms face usually change unfavorably after the revelation of an accounting error. For example, customers of a manufacturing firm may believe that the firm may be more likely to declare bankruptcy in the future after an accounting error and customers may be less likely to purchase goods with warranties thinking that the firm will not remain in business to service the warranty.

have their financial statements audited by an independent external auditor. These mandatory audits potentially reduce firms' credit risk and asymmetric information problems by verifying that financial statements are accurate, in the sense that the statements adhere to generally accepted accounting principles (GAAP) and that users can be reasonably assured that financial statements are free from a material error.[8]

While all publicly traded firms are required to have their financial statements audited, firms have discretion to determine the quantity of auditing services purchased. In other words, firms are free to determine their individual demand for auditing services beyond a minimum quantity. Firms may demand a greater quantity of auditing services beyond the minimum amount to further decrease the likelihood of an accounting error, which should increase the accuracy of their financial statements.[9] Hence, an increase in equilibrium auditing fees due to a shift in the demand curve for auditing services should be associated with a decline in firms' credit risk and asymmetric information problems in the syndicated loan market.[10]

Likewise, as firms are free to choose their own demand for auditing services, auditing firms individually choose their own supply functions for auditing services, which are determined by the costs of providing an audit. The costs of supplying auditing services include both the costs of physically performing audits and the expected future legal liabilities associated with audits. Auditing firms typically face legal liability from audits when a material accounting error that misleads investors is revealed, and auditors fail to detect the accounting error due to negligence in providing audits.[11] Since expected legal liabilities are derived from the expected likelihood of an accounting error or not detecting an accounting error,

[8] A material error is an error that would change a decision made by a user of the financial statements.

[9] For example, when verifying the value of a firm's assets, auditors may value a sample percentage of assets, rather all of the assets; however, firms can request that auditors sample a larger percentage of assets to increase confidence in the valuation of assets stated in their public financial statements.

[10] As will be explained later, if the supply curve is upward sloping, an increase in the demand for auditing services would imply an increase in the equilibrium quantity of auditing services purchased. The increase in the quantity of auditing services purchased is what reduces credit risk and asymmetric information problems.

[11] Auditing firms should be held liable whenever there is a misleading accounting error that was left undetected because of negligently provided audits. Practically, errors are commonly found when borrowers are in financial distress. In addition, auditors are often found liable when auditing clients are in financial distress even when audits were not negligently provided.

an increase in auditing fees due to a shift in the supply curve should be associated with an increase in credit risk and asymmetric information problems in the syndicated loan market. In addition, a shift in the supply curve could also result in a greater likelihood of an accounting error if the equilibrium quantity of auditing services declines.[12]

In this paper, we examine whether an increase in equilibrium auditing fees paid by firms due to an increase in the demand for auditing services is related to credit risk and asymmetric information problems in the syndicated loan market. We base our examination, in part, on the theory that if an increase in auditing fees is due to an increase in the demand curve for auditing services, then an increase in audit fees is associated with a decrease in credit risk and asymmetric information problems. Our examination is also based on the previous theoretical and empirical literature discussing the impact of credit risk and asymmetric information on debt contract terms, which predicts that borrowers with greater credit risk and asymmetric information problems receive loans: (1) with higher interest rates (Diamond 1984); (2) that are more difficult to sell (Leland and Pyle 1977, Diamond 1984, Holmstrom and Tirole 1997, Sufi 2007, Ivashina 2008); (3) with shorter maturities (Flannery 1986, Diamond 1991). Combining data on audit fees from the Audit Analytics database and data on the price and non-price terms of syndicated loan contracts from the DealScan database, we test the hypothesis that if an increase in auditing fees is associated with an decrease in credit risk and asymmetric information, then: (1) the interest spread on a syndicated loan should be negatively associated with auditing fees; (2) the number of lenders in a syndicate should be positively associated with auditing fees; and (3) the maturity length of a syndicated loan should be negatively associated with auditing fees.

There are numerous complications associated with empirically testing our hypothesis. The primary complication is that equilibrium auditing fees are determined by the interaction of the supply and demand curves for auditing services. Hence, an increase in auditing fees

[12]Two mechanisms are at work here: (1) a decrease in supply is associated directly with expected legal liabilities, which should be associated with greater credit risk; (2) a decrease in the supply of auditing services is directly associated with a decrease in the equilibrium quantity of auditing services purchased assuming a downward-sloping demand curve for auditing services.

may be associated with either an increase or decrease in the price and/or quantity of auditing services purchased.[13] In addition auditing fees may be endogenous to syndicated loan contract terms, correlated with unobserved and omitted control variables, and our proxy for auditing fees may be measured with error. In order to overcome these complications, we undertake our analysis with a generalized method of moments (GMM) instrumental variables estimator. We use instruments for the size of firms' inventory, accounts receivable, number of operating segments, and dispersion of economic activity among operating segments as instruments for auditing fees. We choose these instruments first of all because: (1) they are likely to be primary determinants of the demand for auditing fees; (2) they are not endogenous to loan contract terms; (3) they are uncorrelated with relevant unobservable or unintentionally omitted variables; (4) they are uncorrelated with measurement error in auditing fees; and (5) we perceive no strong theoretical argument as to why these variables should instead be used as explanatory variables for loan terms.

Our results indicate that audit fees are associated with syndicated loans with lower interest rates, shorter maturity lengths, and a greater number of lenders. However, our results are consistent with the assertion that demand-induced increases in audit fees influence the interest rate and maturity length of syndicated loans. Our results do not allow us to discern whether increases in the demand for auditing services influence the number of lenders. Overall, we interpret our results as supporting the proposition that an increase in equilibrium auditing fees, due to a shift in the demand curve for auditing services, is associated with a decrease in credit risk and asymmetric information problems in the syndicated loan market.[14,15]

[13] As we discuss later, we assume the quantity of auditing services is the number of hours billed, and the price of auditing services is the hourly fee as in Bell, Landsman and Shackelford (2001).

[14] While investment in inventories could be determined, in part, by the cost of syndicated loan financing or other loan contract terms, our instrumental variables are lagged one period, which reduces the likelihood that the instrumental variables are endogenous to loan features.

[15] We argue that our instrumental variables do not belong in the regression because any information these variables contain for credit risk is likely spanned by the other control variables and there are no definitive predictions regarding these variables and credit risk. For example, while inventories could reflect the existence of more collateral available in the event of default, an increase in inventories could also reflect an unexpected decline in sales.

Our results are important for several reasons. First, the only study examining the implications of accounting errors or financial statement accuracy for debt contracting is Graham, Li and Qiu (2007). However, these authors examine the implications of *realized* accounting errors for debt contracting. In contrast, our study examines the impact of *potential* accounting errors for debt contracting. These authors suggest that accounting errors increase credit risk as perceived by lenders because lenders usually lower expectations about borrowers' profitability following accounting errors, and accounting errors increase asymmetric information problems because financial statement data is less reliable, which widens the information gap between borrowers and lenders. Moreover, our study is the first examining the empirical implications of audit fees for debt contracting.

The second reason our results are important is because the syndicated loan market is a primary source of financing for large publicly traded corporations, and our results provide additional insights regarding the impact of credit risk and asymmetric information in this market.

The third reason our results are important is that our results suggest auditing services mitigate asymmetric information problems with outside investors as intended by the Securities Exchange Act of 1934. Several observers have raised concerns that greater audit fees are no more than auditees paying to get away with accounting malfeasance, but our results suggest that lenders in the syndicated loan market associate a greater quantity of auditing services purchased with a decline in credit risk and asymmetric information problems.

Our results contribute to several literatures. First, our results contribute to the literature regarding the determinants of auditing fees. An implication of the theory by Simunic (1980) is that expected litigation costs are a primary determinant of auditing fees. Dye (1993) provides a model where the supply for auditing fees depends on expected litigation costs resulting from accounting errors, and the demand for auditing services depends on the benefits of more accurate financial statements. Carcello, Hermanson, Neal and Riley (2002) presents empirical evidence that audit fees are greater for better corporate boards, which implies the demand for more accurate accounting records is a determinant of auditing fees.

We find that an increase in the demand for auditing services, which raises equilibrium audit fees and the quantity of audit services purchased, is consistent with a reduction in credit risk and asymmetric information in the syndicated loan market. We interpret this result as suggesting that an increase in the quantity of auditing services purchased is associated with a reduced likelihood of financial statement errors.

Our results contribute to the literature regarding audit fee determination by providing additional evidence that an increase in equilibrium audit fees, as a consequence of an increase in the demand for auditing services, is associated with a reduction in the likelihood of a financial statement error. Moreover, our results contribute to this literature by providing an econometric approach that attempts to separate the influence of the demand for auditing services on audit fees from the impact of the supply for auditing services.

Our results contribute to the literature regarding the influence of asymmetric information problems for the terms of syndicated loan contracts. Diamond (1984) presents a model where the cost of bank loan financing is increasing in the amount of resources lenders allocate to monitoring borrowers to overcome asymmetric information problems. Our results are consistent with the assertion that audit fees reduce asymmetric information, thereby reducing the amount of resources lenders must allocate to overcoming asymmetric information problems, therefore reducing borrowing costs.

Additionally, our results contribute to the literature regarding the incentives to produce information. Several studies provide theoretical justifications regarding barriers to information production about firms' creditworthiness. Hirshleifer (1971) suggests that agents producing information may have a hard time credibly convincing other users that they have produced valuable information. Grossman and Stiglitz (1980) argue that it may not be economically rational to produce information if the producer cannot be certain that their information cannot be resold or transferred without their approval, thereby diminishing the returns to information production. Our results are consistent with the rationale that firms find it beneficial to pay for the production of information that can be used by anyone at zero cost, and that lenders in the syndicated loan market find this information credible.

2 Theoretical Background

In the syndicated loan market, audited financial statements play a crucial role by influencing the extent of borrowers' credit risk and asymmetric information problems.[16] In a typical syndicated loan, a lead bank negotiates the non-price terms of a loan contract (loan amount, maturity length, collateral, covenants, performance pricing) with a borrower for an agreed-upon range of interest rates. Subsequently, the lead bank uses the negotiated loan contract terms to solicit a group of participant lenders willing to provide a portion of the loan's funding. Asymmetric information problems arise when borrowers have private information regarding their creditworthiness that they may use to the detriment of lenders' profitability. Borrowers' financial statements provide a noisy signal regarding borrowers' characteristics, reducing uncertainty regarding borrowers' creditworthiness, which mitigates asymmetric information problems.

Previous research examining the determinants of audit fees suggests that total equilibrium audit fees, which are defined as the price multiplied by the quantity of auditing services, may be either negatively or positively associated with the likelihood of an accounting error (Simunic 1980, Dye 1993), because an increase in auditing fees could be associated with either an increase or decrease in the quantity of auditing services purchased. Typically the quantity of auditing services is defined as hours worked by auditors and the price of auditing services is the hourly fee charged by auditors (Bell, Landsman and Shackelford 2001). These studies predict that an increase in the demand for auditing services should be associated with an increase in the equilibrium price of auditing services, and an increase in the equilibrium quantity of auditing services purchased. Any increase in the equilibrium quantity of auditing services should be associated with a decline in the likelihood of an accounting error.

Typically, auditors verify accounting records by sampling a percentage of a unit of account.

[16] See (Simons 1993, Preece and Mullineaux 1996, Dennis and Mullineaux 2000, Jones, Lang, Nigro and Riley 2001, Lee and Mullineaux 2004, Panyagometh and Roberts 2002, Esty and Megginson 2003, Sufi 2007).

For example, when verifying the value of inventories or accounts receivables, auditors may not verify the value of each unit of inventory or every receivable but will instead verify the value of a percentage of inventories and receivables. Auditors may be able to verify a certain percentage of an account in a given number of hours, which provides a certain level of assurance that there are no accounting errors. Hence, if auditors sample a greater percentage of accounts, there should be an increase in the number of hours billed, and greater assurance that there are no errors in the valuation of these accounts.

The demand for auditing services depends on the benefits of more accurate financial statements, which include a decline in expected losses due to accounting errors and a reduction in asymmetric information problems between firms and outsiders (Graham et al. 2007). When accounting errors are realized, firms may be held liable and forced to pay damages to plaintiffs, which reduces their profitability. Profit expectations are also reduced because accounting errors, more often than not, conceal unfavorable information regarding borrowers' future profitability. In addition, profitability also declines because firms often receive less favorable terms of trade in transactions following accounting errors, due to reputation damage caused by accounting errors. Potential accounting errors may exacerbate asymmetric information problems if borrowers have more knowledge regarding the correct information than lenders, and borrowers use this information advantage to the detriment of lenders' profitability.[17] Hence, an increase in equilibrium auditing fees due to an increase in the demand for auditing services should result in a decline in the likelihood that financial statement errors will be realized in the future, thereby reducing credit risk, and decreasing asymmetric information problems.

These models assert that the supply of auditing services is determined by the costs of physically providing an audit and the expected litigation costs associated with providing an audit. In terms of legal liability, auditors can be held individually liable if plaintiffs can prove

[17] For example, borrowers may fraudulently misrepresent financial statement data in order to inflate financial markets' expectations of their future earnings, thereby distorting financial markets' perception of their credit risk. Hence, financial markets realize that financial statements may not reflect borrowers' true risk characteristics, exacerbating asymmetric information problems.

that auditors did not provide audits consistent with generally accepted auditing standards (GAAS), and may suffer joint liability with audited firms' management if account records fail to adhere to generally accepted accounting principles (GAAP) (Dye 1993). Audits are generally considered to not comply with GAAS when audits do not adequately search for a material accounting error that misleads investors, and accounting records are considered to not comply with GAAP when there are material accounting errors that mislead investors. Since expected legal liabilities are derived from the likelihood of an accounting error, an increase in auditing fees as a result of a decrease in supply should be associated with an increase in credit risk and asymmetric information problems in the syndicated loan market. In addition, if a decrease in the supply for auditing services also lowers the quantity of auditing services purchased, this should also increase the likelihood of a potential accounting error.[18]

Given that potential accounting errors present an asymmetric information problem and additional credit risk, and that an increase in the demand for auditing fees should be related to a decrease in the likelihood of potential accounting errors, we can develop several empirical predictions regarding the association between audit fees and the terms of syndicated loan contracts, based on the literature discussing the impact of credit risk and asymmetric information on debt contracting.

The literature on loan contracting predicts that greater asymmetric information and credit risk is associated with higher loan interest rates. In the theories of Diamond (1991) and Boyd and Prescott (1986), lenders must exert more effort monitoring borrowers suffering from more severe asymmetric information problems, which raises the cost of loan financing. In addition, standard economic theory suggests that if a borrower's expected future profitability declines due to an accounting error, lenders will charge higher interest rates as compensation for greater default risk.

Several studies suggest that greater asymmetric information and credit risk should be as-

[18] Audit fees could also increase due to an increase in the supply of auditing services if the price elasticity of demand is greater than one. While possible, we view this as a less likely scenario.

sociated with smaller lending syndicates. Bolton and Scharfstein (1996) present a model where lenders form smaller lending syndicates when default risk is greater in order to reduce bankruptcy costs, because it is easier to negotiate a resolution with fewer lenders. In addition, models by Leland and Pyle (1977), Diamond (1984), and Holmstrom and Tirole (1997) imply that lenders originating loans will retain a greater ownership stake in a loan to signal the quality of the loan and commit to monitoring the borrower. Sufi (2007) provides empirical evidence that lead lenders in syndicates retain greater ownership stakes in syndicated loans, form smaller syndicates, and form more concentrated syndicates for borrowers suffering from more severe asymmetric information problems, particularly moral hazard problems. Ivashina (2008) presents evidence that lead lenders retain greater ownership stakes in loans in order to reduce asymmetric information problems.[19]

Two different studies provide empirical predictions regarding the impact of default risk and asymmetric information for the maturity of debt financing. Flannery (1986) presents a model with asymmetric information between borrowers and lenders where more creditworthy borrowers will issue short-term debt, when issuing debt requires the payment of transaction costs. They do so because paying repeated transaction costs to issue short-term debt, rather than issuing long-term debt, signals to credit markets that borrowers are more creditworthy. We suggest that greater auditing fees could be a transaction cost that firms face when issuing debt. Diamond (1991) presents a model where borrowers with both low and high credit quality will issue short-term debt and borrowers with moderate credit risk will issue long-term debt. Because our study focuses on borrowers with high or moderate levels of credit quality, we predict that borrowers with greater credit quality should borrow at shorter maturities.

Based upon the preceding discussion, we have three empirically testable predictions. If an increase in equilibrium audit fees due to an increase in the demand for auditing services is

[19]When we refer to asymmetric information problems in the syndicated loan market, we refer to two separate problems: those between lenders and borrowers, and those between lead lenders and participant lenders. We suggest that potential accounting errors influence these asymmetric information problems in the same manner.

associated with a decrease (increase) in credit risk and asymmetric information, then:

- audit fees are negatively (positively) associated with loan interest rates,
- audit fees are positively (negatively) associated with the number of lenders in a syndicated loan, and
- audit fees are negatively (positively) associated with the maturity of a syndicated loan.

3 Empirical Model and Sample Selection

We begin constructing our data sample with the Audit Analytics database, a database containing detailed audit information for more than 15,000 corporations filing public financial statements with the Securities and Exchange Commission (SEC). From this database, we gather data on firms' audit fees and non-audit fees. Audit fees include the cost of performing the audit, while non-audit fees include compensation for other ancillary services provided by auditors, such as tax preparation services.[20] We then merge the Audit Analytics database with the Loan Pricing Corporation's DealScan database, a database containing information regarding the price and non-price loan contract terms for loans to large corporations.[21] We combine observations from the merged Audit Analytics-DealScan database with accompanying financial statement data from Compustat and stock price data from the Center for Research in Securities Prices (CRSP) database. The unit of observation in our database is a loan facility obtained by a firm in a given fiscal year. The sample, with all loan facilities included, contains observations on 4,668 loan facilities merged to the aforementioned data sets and spans the years 2000-2007. We then randomly choose one loan facility

[20] As we later mention, we implement other measures of audit fees and the qualitative results are unchanged.

[21] We gather the following loan information from the DealScan database: the loan interest rate, the number of lenders, the loan amount, whether the loan is secured or unsecured, whether the loan has financial or general covenants, whether the loan has performance pricing, the type of loan (i.e., loan commitment, term loan), the loan purpose, the loan seniority, and the distribution method (i.e., syndicated loan, sole lender loan).

per year for each firm and arrive at a final sample of 2,971 loan facilities.[22] We are limited to this time span because the Audit Analytics database does not provide audit information prior to 2000. In addition, we note that all dependent variables constructed from the Audit Analytics, Compustat and CRSP data are lagged one fiscal year prior to the beginning of the loan facility to ensure that the information was available to lenders when negotiating loan contract terms.

Our empirical exercise uses this data sample to estimate the following model:

$$Y_{i,t} = \delta fee_{i,t-1} + \beta' X + \omega_i + \gamma_t + \varepsilon_{i,t} \quad (1)$$

Equation (1) presents the general model describing the interest rate spread, the number of lenders, and the maturity length of syndicated loans. The interest rate spread is the All-In-Drawn Spread from the DealScan database, which is the loan interest rate spread over LIBOR in basis points; the number of lenders is calculated as the log of number of lenders; and the maturity length of the loan is the log of the maturity length in days. In equation (1) the subscript i denotes the firm and the subscript t denotes the year. The dependent variable Y is either the interest rate spread, the number of lenders, or the maturity length. The matrix X includes independent variables dated $t-1$, which serve as proxy for credit risk and asymmetric information problems, and are standard from the literature (Strahan 1999, Carey, Post and Sharpe 1998, Hubbard, Kuttner and Palia 2002, Graham et al. 2007). The error term is composed of three components: ω_i, which is the firm-specific error term; γ_t, the year-specific error term; and $\varepsilon_{i,t}$, a white noise error term.

We calculate our proxy for audit fees as total audit fees plus non-audit fees divided by total assets. We use this measure to capture the possibility that firms compensate their auditors for their auditing activities by purchasing additional non-audit-related consulting services. For example, several studies suggest that firms may compensate auditing firms' for bearing additional litigation risk by purchasing additional services, such as tax preparation ser-

[22] Previous research follows this approach, for example, see Sufi (2007) and Ivashina (2008).

vices.[23]

The observable risk characteristics in equation (1) that are included in X are intended to capture banks' pricing of risks related to credit risk and asymmetric information problems. These variables include: a proxy for the firm size (log of total assets), the leverage ratio (the book value of debt divided by the book value of assets), research and development (research and development expense divided by total assets), dividends (total dividends divided by total assets), current assets (current assets divided by total assets), the quick ratio (current assets minus current liabilities all divided by total liabilities), Tobin's average Q (the market value of equity plus the book value of debt divided by total assets), cumulative monthly stock returns from the previous fiscal year, and the standard deviation of monthly stock returns from the previous fiscal year.[24] In addition, we construct a proxy for the firms' Standard & Poor's (S & P) domestic issuer rating, which takes on 23 values, where the debt rating is more favorable for higher values of this indicator.[25] We expect control variables that capture greater (lesser) credit risk or asymmetric information problems to have the same (opposite) predicted associations with the dependent variables as audit fees. We expect greater values of the debt rating, total assets, current assets, the quick ratio, earnings before interest, taxes, depreciation, and amortization (EBITDA), cumulative stock returns, and Tobin's average Q to be associated with less credit risk and asymmetric information problems; and we expect an increase in research and development spending, leverage, debt due in one year, and the standard deviation of stock returns to be associated with greater credit risk and asymmetric information problems. We offer no predictions as to how dividends should be associated with credit risk and asymmetric information problems.

The non-price loan terms capture how lenders use loan features to mitigate credit risk and asymmetric information problems (Strahan 1999). These include an indicator for whether

[23] We also estimated all models using only audit-related fees divided by lagged total assets as our proxy for audit fees, and results were qualitatively similar.

[24] Other studies examining the empirical determinants of loan contact terms include Carey, Post and Sharpe (1998), Hubbard, Kuttner and Palia (2002), Guner (2006) and Qian and Strahan (2007). Specific construction of each variable is standard in the literature and included in the appendix.

[25] We set missing values of the debt rating equal to zero and generate an indicator variable equal to 1 when the debt rating is not missing.

or not the loan is secured, the log of the size of the loan facility, a dummy variable indicating whether the loan facility has financial covenants, a dummy variable indicating whether the loan facility has general covenants, and a dummy variable indicating whether a loan has performance pricing. In addition, we construct indicators for the loan type and purpose. Because we do not control for the endogeneity of loan contract terms, we do not offer any coefficient predictions. For example, Strahan (1999) finds that interest rate spreads are greater for secured loans, and Booth and Booth (2006) find that after controlling for the endogeneity of a loan being secured, secured loans carry lower interest rate spreads.

Our main objective is to obtain empirical estimates of the association between the quantity of auditing services and the dependent variables in equation (1). There are several complications to achieving this objective, which include: (1) we do not have data regarding the quantity of auditing services; (2) audit fees may be endogenous to the dependent variables; (3) audit fees may be measured with error; (4) audit fees may be correlated with unintentionally omitted or unobservable variables that explain the dependent variables. Therefore, we estimate equation (1) with instrumental variables generalized method of moments (IV-GMM) to identify the effect in audit fees, due to an increase in the demand for auditing services, on each dependent variable. IV-GMM parameter estimates are efficient and consistent in the presence of heteroskedasticity.

To implement the estimator, we need instrumental variables that are expected to be associated with an increase in demand for auditing services and not the supply of auditing services, correlated with audit fees, and uncorrelated with the error term in equation (1). We rely on the theory of Dye (1993), which implies that the demand for audit services depends on the benefits of more accurate accounting records, and the supply of audit fees are a function of the cost of performing an audit and the expected litigation costs associated with an audit's expected legal liability. Several studies suggest that audit liability is greatest when an audited firm defaults on a debt obligation, often leaving the auditing firm as the only entity with funds to reimburse creditors, which may suggest several proxies for default risk may be suitable instrumental variables that may capture shifts in the supply curve for audit fees. However, since default risk should influence the demand for more accurate accounting records, these variables would likely be associated with a shift in the demand curve for auditing services. Hence, variables capturing credit risk would not be suitable instrumental variables for identifying shifts in the demand or supply of auditing services. Therefore, we must choose another set of instrumental variables that are likely to be associated with a shift in the demand curve for auditing services. We derive our instrumental variables from Dye's implication that audit fees depend on the benefits of accurate accounting records. Auditing clients wish to have an audit that provides a certain level of assurance that financial statements are free from errors.

We also consider the assertion of Bell, Landsman and Shackelford (2001) and argue that the quantity of auditing services is captured by the hours billed by auditors and the price of auditing services is the hourly fee. Based on these assertions, it is reasonable to assume that auditing clients purchase a given amount of audit hours to achieve a certain level of assurance that accounting records are free from error. As previously mentioned, as variables that capture the marginal benefit of assurance are likely to be associated with credit quality or unobservable, we utilize variables that capture the need for clients to hire a greater number of auditing hours to achieve a given level of assurance. In a sense, these instrumental variables capture an increase in the quantity of auditor hours demanded, holding the marginal benefit of assurance constant. Our instruments include proxies for the scale of accounts receivable and inventories, the number of operating segments, and dispersion of economic activity among operating segments.

We justify accounts receivable and inventories based on the notion that auditors typically sample a certain percentage of these accounts to provide a given level of assurance. Hence, if a firm increases the scale of either of these items, holding all else constant, an audit would require a larger sample and a greater number of auditor hours, thus an increase in the quantity of auditing services purchased. We construct proxies for the scale of accounts receivable as total accounts receivable divided by total assets and total inventories divided by total assets. Instrumental variables are lagged to the fiscal year prior to the loan contract, concurrent with our audit fee proxy.

A second set of instrumental variables are based on the concept that more complex firms must purchase a greater number of audit hours to achieve a given level of assurance that accounting records are free from error. Our two proxies for complexity are the number of operating segments that comprise a firm and a Herfindahl Hirschmann Index (HHI) of sales among operating segments. If a firm has a greater number of segments, as stated by Simunic (1984), firms must have accounting records verified for more "decision centers." In addition, if economic activity is more evenly dispersed among segments, then auditing activities will have to be dispersed among more decision centers.

In order to provide assurance that our instruments are appropriate, they must not: (1) shift the supply curve for auditing services (influence the marginal cost of providing an hour of auditing services), (2) not be endogenous to loan contract terms, (3) must not have measurement error correlated with the error term, (4) and must not be correlated with omitted variables. We argue it is reasonable to assume that our instrumental variables are robust to these potential problems. We argue that none of our variables influence the *marginal cost* of providing an *hour* of auditing services, but instead capture firms' increased demand for hours to achieve a given level of assurance that accounting records are free from a material error. We maintain that our instruments are not endogenous to loan contract terms because the instruments are dated as of the fiscal year prior to the loan contract. In addition, it is unlikely that measurement error in our instruments are correlated with the error terms. Finally, we suggest that our variables are not correlated with any omitted variable because previous examinations of the empirical determinants of loan contract terms typically do not include these "readily available" variables as explanatory variables for loan contract terms. Our host of other control variables, such as debt ratings and stock market valuations, likely better capture the information these variables may contain for loan contract terms.

4 Estimation Results

Before estimating equation (1) with instrumental variables with the IV-GMM method, we estimate the model simply by using Ordinary Least Squares (OLS). In OLS analysis we do not include instrumental variables for audit fees, however we control for industry and year effects and use robust standard errors clustered by firm. The results are presented in Table 1. In Column (1) we investigate the relation between all-in-drawn spread and the audit fees. The results indicate that audit fees have a positive and statistically significant association with loan interest rate spreads after controlling for firms' observable risk characteristics and non-price loan terms. Looking at the parameter estimates for the non-price loan terms in column (1), we see a negative and significant relation between the deal amount and the all-in-drawn spread. Similarly, the relation between number of lenders and the all-in-drawn spread is negative and significant. A secured loan is more likely to get a higher interest rate, whereas a loan that has performance pricing is more likely to get a lower interest rate. Higher-term loans, revolvers, and takeovers are also associated with higher spreads. Looking at the firm characteristics, we find that the lagged values of EBITDA, total assets, Tobin's average Q, sales, and firms' debt rating are negatively related to the All-In-Drawn Spread. An increase in leverage, cumulative stock returns and standard deviation of stock returns are positively related to the all-in-drawn spread. This result appears to indicate that audit fees are associated with greater credit risk and asymmetric information problems.

Table 1: OLS

	(1)	(2)	(3)
	All-in-Drawn Spread	No. of Lenders	Maturity
Audit Fee	26.9613***	15.7969**	-11.0665**
	(6.563)	(7.917)	(5.573)
Deal Amount	-0.0694***	0.4082***	0.0544***

Continued on next page

Table 1 – continued from previous page

	(1) All-in-Drawn Spread	(2) No. of Lenders	(3) Maturity
	(0.019)	(0.021)	(0.018)
Maturity Length	-0.0161		
	(0.027)		
Number of Lenders	-0.0447***		
	(0.016)		
Secured/Unsecured	0.2947***	-0.1798***	0.0316
	(0.028)	(0.035)	(0.022)
Secured Dummy	-0.0701**	-0.0164	-0.0183
	(0.028)	(0.038)	(0.026)
General Covenant Dummy	0.0572	0.2851***	0.0847**
	(0.040)	(0.054)	(0.037)
Financial Covenant Dummy	0.0288	-0.0256	-0.1353***
	(0.032)	(0.046)	(0.031)
Perf. Pricing Dummy	-0.0779***	0.0783*	0.0474
	(0.029)	(0.043)	(0.030)
Term Loan	0.4657***	0.0186	1.2749***
	(0.057)	(0.056)	(0.050)
Revolver/Line $\geq$ 1 Year	0.1377***	0.1007***	1.1752***
	(0.045)	(0.038)	(0.033)
Takeover	0.1584***	-0.1735**	-0.0186
	(0.041)	(0.074)	(0.046)
Debt Repay.	0.0595*	-0.1061*	0.1006**
	(0.034)	(0.057)	(0.040)
EBITDA	-0.8396***	0.0768	0.2175
	(0.138)	(0.137)	(0.135)
Total Assets	-0.0419**	0.0436**	-0.0102

Continued on next page

Table 1 – continued from previous page

	(1) All-in-Drawn Spread	(2) No. of Lenders	(3) Maturity
	(0.016)	(0.019)	(0.015)
Tobin's Average Q	-0.0880***	-0.0176	-0.0013
	(0.011)	(0.012)	(0.009)
Sales	-0.0254*	0.0303*	-0.0003
	(0.014)	(0.018)	(0.012)
Dividends	-0.9138	-0.1101	0.5089
	(0.607)	(0.749)	(0.400)
Leverage	0.3586***	0.0460	-0.0116
	(0.069)	(0.092)	(0.060)
Debt Due In One Year	0.0017	-0.0402	-0.0489
	(0.061)	(0.068)	(0.042)
Cum. Stock Returns	0.1163**	0.0567	0.0923*
	(0.049)	(0.069)	(0.053)
St. Dev. Stock Returns	0.7671***	-1.4146***	-0.1992
	(0.188)	(0.219)	(0.167)
Debt Rating	-0.1337***	-0.0103	-0.0191***
	(0.006)	(0.007)	(0.005)
Debt Rating Dummy	1.6923***	0.2184**	0.3187***
	(0.079)	(0.098)	(0.065)
Constant	6.1612***	-6.6348***	5.1110***
	(0.318)	(0.327)	(0.286)
R^2	0.7614	0.5817	0.6581
N	2971	2971	2971

* $p < 0.10$, ** $p < .05$, *** $p < .01$

Next, in Column (2) we have the number of lenders as our dependent variable, and examine the effect of audit fees on the number of lenders. The coefficient on the audit fee is positive and statistically significant. The number of lenders is positively related with audit fees, consistent with the assertion that firms paying higher audit fees have lower asymmetric information and/or lower credit risk, and can borrow from syndicates that have more lenders. However, because the ordinary least squares (OLS) estimates do not identify a shift in either the demand or supply curve for auditing services, we cannot infer whether or not the increase in audit fees is associated with an increase in the quantity of auditing services. Examining the results for the observable risk chracteristics, total assets are generally associated with fewer asymmetric information problems and are positively associated with the number of lenders. Interestingly, several observable risk characteristics have no significant association with the number of lenders. Firm sales are also positively related to the number of lenders, however the relation is negative for the variation in the stock returns and the number of lenders. The non-price loan terms have some explanatory power for the number of lenders. Revolver loans and the presence of general covenants and performance pricing is positively associated with the number of lenders, while secured loans, takeover and debt repayment loans have fewer lenders.

In column (3), we find a negative and significant relation between audit fees and maturity length, which is consistent with Diamond (1991) and Flannery (1986) where borrowers with high credit quality will issue short-term debt. Audit fees may be similar to the transaction costs posited by Flannery (1986) or an observable signal used to determine borrower's riskiness as suggested by Diamond (1991). The observable characteristics of the firms do not seem to matter very much for the determination of the maturity of the loan except for asset size and debt rating. However, the non-price loan terms have a substantial effect on the maturity. Higher term loans and revolvers, and loans that have general covenants are more likely to be made for a longer maturity. However, loans that have financial covenants are associated with shorter maturities.

Our main estimation results are presented in Table 2, where we use GMM two-step estimation with robust standard errors.[26] In this specification we use all the instruments; accounts receivable, inventories, number of operating segments, and HHI.[27] In column (1) the all-in-drawn spread is used as the dependent variable for the Equation (1). These results indicate that audit fees have a negative and statistically significant association with loan interest rate spreads. In addition, we note that audit fees retain significant explanatory power for loan spreads after controlling for firms' observable risk characteristics and non-price loan terms. This is important because more accurate financial statements may only influence loan terms through the weights banks place on information contained in the financial statements. However, our result implies that audit fees may be associated with a reduction in asymmetric information and credit risk beyond the more accurate information contained in financial statement data. Moreover, the results indicate that audit fees are negatively associated with loan spreads after controlling for credit risk, which could be a primary determinant of audit fees because audit fees are likely to depend on legal liabilities that ensue when borrowers are in financial distress. This result supports the assertion that, holding all else constant, more precise financial statements are associated with greater expected future profitability, hence, lower credit risk, and lower monitoring costs that need to be incurred to overcome asymmetric information problems.

Table 2: GMM 2-Stage with All Instruments

	(1) All-in-Drawn Spread	(2) No. of Lenders	(3) Maturity
Audit Fee	-63.6158**	65.9619	-45.8753
	(31.964)	(42.172)	(30.271)
Deal Amount	-0.0775***	0.4108***	0.0518***
	(0.018)	(0.020)	(0.017)

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[26] For the two step estimations we used the Stata's routine by Baum, Schaffer and Stillman (2008).
[27] The first stage estimations are presented in Table 5 in Appendix B.

Table 2 – continued from previous page

	(1)	(2)	(3)
	All-in-Drawn Spread	No. of Lenders	Maturity
Maturity Length	-0.0308		
	(0.027)		
Number of Lenders	-0.0354**		
	(0.016)		
Secured/Unsecured	0.3081***	-0.1845***	0.0349
	(0.025)	(0.033)	(0.022)
Secured Dummy	-0.0722***	-0.0145	-0.0211
	(0.027)	(0.036)	(0.025)
General Covenant Dummy	0.0488	0.2846***	0.0827**
	(0.041)	(0.053)	(0.038)
Financial Covenant Dummy	0.0339	-0.0293	-0.1295***
	(0.034)	(0.044)	(0.030)
Perf. Pricing Dummy	-0.0851***	0.0842**	0.0405
	(0.029)	(0.042)	(0.029)
Term Loan	0.4704***	0.0249	1.2669***
	(0.057)	(0.054)	(0.047)
Revolver/Line$\geq$ 1 Year	0.1309***	0.1137***	1.1674***
	(0.044)	(0.037)	(0.032)
Takeover	0.1743***	-0.1809**	-0.0143
	(0.043)	(0.072)	(0.046)
Debt Repay.	0.0521	-0.1016*	0.0983**
	(0.036)	(0.058)	(0.040)
EBITDA	-1.0171***	0.1781	0.1382
	(0.173)	(0.161)	(0.150)
Total Assets	-0.0984***	0.0761**	-0.0322
	(0.024)	(0.031)	(0.024)

Continued on next page

Table 2 – continued from previous page

	(1)	(2)	(3)
	All-in-Drawn Spread	No. of Lenders	Maturity
Tobin's Average Q	-0.0718***	-0.0262**	0.0052
	(0.012)	(0.013)	(0.010)
Sales	-0.0048	0.0195	0.0070
	(0.014)	(0.019)	(0.012)
Dividends	-0.5164	-0.3483	0.6242
	(0.576)	(0.716)	(0.418)
Leverage	0.3867***	0.0321	0.0049
	(0.061)	(0.083)	(0.059)
Debt Due In One Year	0.0532	-0.0688	-0.0259
	(0.061)	(0.071)	(0.047)
Cum. Stock Returns	0.1407***	0.0416	0.0876*
	(0.052)	(0.067)	(0.052)
St. Dev. Stock Returns	0.9744***	-1.5330***	-0.1420
	(0.209)	(0.225)	(0.174)
Debt Rating	-0.1277***	-0.0141**	-0.0171***
	(0.006)	(0.007)	(0.005)
Debt Rating Dummy	1.6122***	0.2701***	0.2943***
	(0.075)	(0.095)	(0.063)
Constant	6.9549***	-7.0929***	5.4117***
	(0.406)	(0.436)	(0.350)
R^2	0.7408	0.5758	0.6529
Hansen's J p-value	0.8651	0.6155	0.2472
Under-iden. p-value	0.0000	0.0000	0.0000
Endogeneity	0.0020	0.2250	0.2313
N	2971	2971	2971

* $p < 0.10$, ** $p < .05$, *** $p < .01$

Looking at the risk characteristics we see that firms' observable risk characteristics have explanatory power for loan spreads. Coefficient estimates are generally consistent with expectations. Loan interest rate spreads are decreasing in firms' total assets, Tobin's average Q, and EBITDA, which are all variables typically associated with lower credit risk and asymmetric information problems, while leverage and standard deviation of stock returns, generally associated with greater credit risk and asymmetric information problems, are positively associated with loan spreads. A better debt rating, which indicates a greater ability and willingness to repay debt, also reduces credit risk and asymmetric information problems, which results in lower interest rate spreads. For the non-price loan terms, an increase in the number of lenders and having performance pricing is negatively associated with loan spreads, while the presence of general or financial covenants are not significantly associated with loan spreads. Also, higher term loans, revolvers and takeovers seem to be positively related to the all-in-drawn spread. These results are all generally consistent with previous research examining the empirical determinants of loan spreads.

Next, in column (2) we replicate our analysis; however, this time we use number of lenders as our dependent variable. As can be seen in column (2), there is a positive but not significant relation between the number of lenders and audit fees. This means audit fees do not have any significant explanatory power. Looking at the firm characteristics, we see that higher total assets are positively associated with number of lenders, whereas higher Tobin's average Q, more variables stock returns or higher debt rating imply a higher number of lenders. Looking at the non-price terms of the loans, we see that secured loans and takeovers can have fewer lenders, while loans with general covenants, performance pricing or revolver loans can have more lenders.

Afterward in column (3) we replicate our analysis by using maturity of the loan as our dependent variable. We find a negative but not significant association between audit fees and the maturity. Mots of the characteristics of the firms do not seem to matter for the maturity.

Higher cumulative stocks returns imply a longer maturity but higher debt rating implies a shorter maturity. Term loans and revolver loans are associated with longer maturities. Also, if a loan has general covenants the maturity is longer, but if a loan has financial covenants the maturity is shorter.

It is important to note that identification of the exogenous influence of audit fees on the dependent variables relies on our instrumental variables being correlated with audit fees and uncorrelated with the error terms in equation (1). In other words, our instrumental variables must have reasonably potent correlation with audit fees in order to identify the exogenous influence of auditing fees on the dependent variables. Therefore, we examine the p-values from the test of under-identification to examine whether audit fees are reasonably correlated with our instrumental variables excluded from the second stage regression. The null hypothesis in the test of under-identification is that the instrumental variables excluded from the first stage are not correlated with audit fees. We reject the null hypothesis at the 1 percent level for all estimations in three columns. In order to make inferences as to the possible correlation between the instrumental variables and the error terms in equation (1), we examine the p-values for the test of over-identification. For the Hansen's J test of over-identification, the null hypothesis is that the instruments are uncorrelated with the error term, and we fail to reject the null hypothesis at any reasonable level for all three columns. In summary, we find no strong evidence rejecting the validity of our instrumental variables.

We also implement an endogeneity test, where under the null hypothesis audit fees can be treated as exogenous. For the estimation in column (1), we reject the null hypothesis, which implies that audit fees are endogenous to the all-in-drawn spread, and using an instrumental variables approach is relevant. However, checking the endogeneity test results in columns (2) and (3), we fail to reject the null hypothesis that Audit Fees are exogenous to the number of lenders and maturity. Since specification tests for the models presented in columns (2) and (3) reject the hypothesis that audit fees are exogenous to interest rate spreads, we will be unable to elaborate on the meaning of the parameter estimates in these columns.

As can be seen from the first stage estimations are presented in Table 5 in Appendix B, there is not a significant association between inventories and audit fees, and the number of segments and accounts receivable seem to matter the most among other instruments. Hence we replicate our analysis by using only number of segments and accounts receivable as instruments. The results are presented in Table 3.

Table 3: GMM 2-Stage with Accounts Receivables and No. of Segments

	(1)	(2)	(3)
	All-in-Drawn Spread	No. of Lenders	Maturity
Audit Fee	-63.5671*	78.2227*	-57.3611*
	(33.009)	(43.558)	(31.256)
Deal Amount	-0.0775***	0.4110***	0.0502***
	(0.018)	(0.020)	(0.017)
Maturity Length	-0.0308		
	(0.027)		
Number of Lenders	-0.0354**		
	(0.016)		
Secured/Unsecured	0.3080***	-0.1874***	0.0366*
	(0.025)	(0.033)	(0.022)
Secured Dummy	-0.0722***	-0.0143	-0.0207
	(0.027)	(0.036)	(0.025)
General Covenant Dummy	0.0489	0.2895***	0.0840**
	(0.041)	(0.053)	(0.039)
Financial Covenant Dummy	0.0339	-0.0309	-0.1327***
	(0.034)	(0.044)	(0.030)
Perf. Pricing Dummy	-0.0851***	0.0837**	0.0411
	(0.029)	(0.042)	(0.029)

Continued on next page

Table 3 – continued from previous page

	(1) All-in-Drawn Spread	(2) No. of Lenders	(3) Maturity
Term Loan	0.4704***	0.0286	1.2693***
	(0.057)	(0.054)	(0.047)
Revolver/Line $\geq$ 1 Year	0.1309***	0.1169***	1.1651***
	(0.044)	(0.037)	(0.032)
Takeover	0.1742***	-0.1823**	-0.0102
	(0.043)	(0.072)	(0.047)
Debt Repay.	0.0521	-0.0993*	0.0946**
	(0.036)	(0.058)	(0.040)
EBITDA	-1.0171***	0.2129	0.1350
	(0.173)	(0.165)	(0.151)
Total Assets	-0.0983***	0.0828***	-0.0376
	(0.025)	(0.031)	(0.024)
Tobin's Average Q	-0.0718***	-0.0289**	0.0068
	(0.012)	(0.013)	(0.011)
Sales	-0.0049	0.0161	0.0108
	(0.014)	(0.020)	(0.013)
Dividends	-0.5168	-0.3789	0.7087*
	(0.579)	(0.719)	(0.429)
Leverage	0.3867***	0.0287	0.0087
	(0.061)	(0.083)	(0.060)
Debt Due In One Year	0.0532	-0.0758	-0.0217
	(0.061)	(0.071)	(0.048)
Cum. Stock Returns	0.1407***	0.0399	0.1016*
	(0.052)	(0.067)	(0.053)
St. Dev. Stock Returns	0.9743***	-1.5601***	-0.1070
	(0.209)	(0.227)	(0.176)

Continued on next page

Table 3 – continued from previous page

	(1) All-in-Drawn Spread	(2) No. of Lenders	(3) Maturity
Debt Rating	-0.1277***	-0.0144**	-0.0160***
	(0.006)	(0.007)	(0.005)
Debt Rating Dummy	1.6123***	0.2741***	0.2766***
	(0.076)	(0.096)	(0.065)
Constant	6.9144***	-7.1613***	5.4813***
	(0.413)	(0.445)	(0.353)
R^2	0.7408	0.5727	0.6490
Hansen's J p-value	0.6926	0.7260	0.4874
Under-iden. p-value	0.0000	0.0000	0.0000
Endogeneity	0.0031	0.1408	0.1215
N	2971	2971	2971

* $p < 0.10$, ** $p < .05$, *** $p < .01$

The results in column (1) are in line with our previous findings that there is a negative and significant relationship between audit fees and all-in-drawn spread. The significance of the variables for the risk characteristics of the firms and the non-price terms of the loans do not change. The results in columns (2) and (3) are substantially different from our previous table. In column (2) where we have the number of lenders as our dependent variable, and the coefficient on the audit fee is positive and statistically significant. The number of lenders is positively related with the audit fee, consistent with the assertion that firms that pay higher audit fees have less asymmetric information and/or lower credit risk, and can borrow from syndicates that have more lenders. In column (3), where we have the number of lenders as our dependent variable, we find a negative and significant relation between the audit fee and the maturity length.

Next, we check for the under-identification test, and reject the the null hypothesis that the instrumental variables excluded from the first stage are not correlated with audit fees for all three columns. For the Hansen's J test of over-identification, we fail to reject the null hypothesis that the instruments are uncorrelated with the error term. Checking for the endogeneity, we find that audit fees cannot be treated as exogenous to the all-in-drawn spread as can be seen in column (1). However, we fail to reject the null hypothesis that the audit fees are exogenous to the number of lenders and the maturity as can be seen in columns (2) and (3).

So, we argue that since audit fees can be treated as exogenous, the estimation results in Table 1 where we do not employ instrumental variables is relevant, and there is a positive association between audit fees and number of lenders, and there is a negative association between audit fees and maturity, which is consistent with the argument that an exogenous increase in audit fees is associated with an decrease in credit risk and asymmetric information problems. However, as mentioned earlier, the results do not allow us to discern a specific interpretation of these result. Moreover, when comparing these results to those in Table 2 or Table 3, it may seem that we should assert our results provide mixed inferences regarding whether un-instrumented audit fees are associated with an increase or decrease in credit risk and asymmetric information problems. However, we remind the reader that we reject the null hypothesis that audit fees are exogenous to the interest rate spread, but not the number of lenders or the maturity.

5 Conclusion

Our estimation results support the view that increases in audit fees are driven by audit clients' demand for more accurate financial statements, which implies a lower likelihood of material accounting errors, resulting in a decline in credit risk and asymmetric information problems in the syndicated loan market. In addition, our results are consistent with the rationale that firms find it beneficial to pay for the production of information that can be used by anyone at zero cost, and that lenders in the syndicated loan market find this information credible. We interpret our results as suggesting that borrowers find it economically advantageous to substitute banks' monitoring with information production by auditing firms. Possibly this information could also be used by many financial market participants other than banks. In addition, our results suggest that audits serve the purpose stated in the Securities Exchange Act of 1934: that audits are intended to mitigate asymmetric information problems in financial markets.

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Appendix A: Variable Construction

- All-In-Drawn Spread: Taken directly from DealScan database
- Number of Lenders: Log of 1 + number of lenders from DealScan
- Maturity Length: Log of maturity length of loan in days from DealScan
- Deal Amount: Log of deal amount in dollars from DealScan
- Secured/Unsecured Dummy: Equal to 1 if loan is secured, and equal to 0 if loan is unsecured or secured status is missing, from DealScan
- Covenant Dummy: Equal to 1 if loan has either general or financial covenants, from DealScan
- Performance Pricing Dummy: Equal to 1 if loan has performance pricing from DealScan
- Debt Rating: Compustat item280, takes on increasing values beginning with least favorable rating and running to most favorable rating
- Research and Development: Compustat item45/item6
- Leverage: Compustat (item9 + item34)/item6
- Total Assets: Compustat log(item6)
- Current Assets: Compustat item4/data5
- Quick Ratio: Compustat (item1 + item238 + .6*item2)/item5
- EBITDA: Compustat (item12+item14)/item6
- Debt Due in One Year: Compustat item44/(item9 + item34)
- Dividends: Compustat (item19 + item21)/item6

- Tobin's Average Q: Compustat (item199*item25 + item9 + item34)/item6
- Cumulative Stock Returns: Cumulative stock returns from previous fiscal year from CRSP, stock return is firm's daily stock return minus CRSP daily value weighted index return
- Cumulative Stock Returns: Standard deviation of daily stock returns from previous fiscal year, stock return is firm's daily stock return minus CRSP daily value weighted index return

Appendix B: Additional Tables

Table 5: First Stage - All Instruments

	(1) All-in-Drawn Spread	(2) No. of Lenders	(3) Maturity
No of Segments	0.0001***	0.0001***	0.0001***
	(0.000)	(0.000)	(0.000)
Accounts Receivable	0.0013***	0.0014***	0.0014***
	(0.000)	(0.000)	(0.000)
Inventory	-0.0001	-0.0001	-0.0001
	(0.000)	(0.000)	(0.000)
HHI	-0.0000**	-0.0000**	-0.0000**
	(0.000)	(0.000)	(0.000)
Deal Amount	-0.0001	-0.0000	-0.0000
	(0.000)	(0.000)	(0.000)
Maturity Length	-0.0001**		
	(0.000)		
Number of Lenders	0.0001**		
	(0.000)		
Secured/Unsecured	0.0002**	0.0001*	0.0001*
	(0.000)	(0.000)	(0.000)
Secured Dummy	-0.0000	-0.0000	-0.0000
	(0.000)	(0.000)	(0.000)
General Covenant Dummy	-0.0001	-0.0001	-0.0001
	(0.000)	(0.000)	(0.000)
Financial Covenant Dummy	0.0001	0.0001	0.0001
	(0.000)	(0.000)	(0.000)
Perf. Pricing Dummy	-0.0000	-0.0000	-0.0000

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Table 5 – continued from previous page

	(1)	(2)	(3)
	All-in-Drawn Spread	No. of Lenders	Maturity
	(0.000)	(0.000)	(0.000)
Term Loan	0.0000	-0.0001	-0.0001
	(0.000)	(0.000)	(0.000)
Revolver/Line ≥1 Year	-0.0001	-0.0003***	-0.0003***
	(0.000)	(0.000)	(0.000)
Takeover	0.0001	0.0001	0.0001
	(0.000)	(0.000)	(0.000)
Debt Repay.	-0.0001	-0.0001	-0.0001
	(0.000)	(0.000)	(0.000)
Constant	0.0082***	0.0069***	0.0069***
	(0.001)	(0.001)	(0.001)
EBITDA	-0.0019***	-0.0020***	-0.0020***
	(0.001)	(0.001)	(0.001)
Total Assets	-0.0007***	-0.0007***	-0.0007***
	(0.000)	(0.000)	(0.000)
Tobin's Average Q	0.0002***	0.0002***	0.0002***
	(0.000)	(0.000)	(0.000)
Sales	0.0001***	0.0001***	0.0001***
	(0.000)	(0.000)	(0.000)
Dividends	0.0043**	0.0042**	0.0042**
	(0.002)	(0.002)	(0.002)
Leverage	0.0003	0.0003	0.0003
	(0.000)	(0.000)	(0.000)
Debt Due In One Year	0.0005**	0.0005**	0.0005**
	(0.000)	(0.000)	(0.000)
Cum. Stock Returns	0.0002	0.0002	0.0002

Continued on next page

Table 5 – continued from previous page

	(1)	(2)	(3)
	All-in-Drawn Spread	No. of Lenders	Maturity
	(0.000)	(0.000)	(0.000)
St. Dev. Stock Returns	0.0025***	0.0024***	0.0024***
	(0.001)	(0.001)	(0.001)
Debt Rating	0.0001***	0.0001***	0.0001***
	(0.000)	(0.000)	(0.000)
Debt Rating Dummy	-0.0007***	-0.0007***	-0.0007***
	(0.000)	(0.000)	(0.000)
R^2	0.4751	0.4741	0.4741
N	2971	2971	2971

* $p < 0.10$, ** $p < .05$, *** $p < .01$

Table 4: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.
All-In-Drawn Spread	4.599838	0.8650443	2.140066	7.279319
Audit Fee	0.0018273	0.0018588	0	0.0108805
HHI	3935.699	1950.317	1118.812	10000
No of Segments	5.845843	3.120012	1	13
Accounts Receivable	0.1560044	0.1125952	0	0.6199169
Inventory	0.1373406	0.134155	0	0.6919741
Deal Amount	19.24848	1.331465	12.57097	23.90132
Maturity Length	7.038647	0.6680322	4.997212	7.980023
Number of Lenders	1.877628	0.902066	0	3.526361
Secured/Unsecured	0.3749579	0.4841935	0	1
Secured Dummy	0.6415348	0.4796304	0	1
General Covenant Dummy	0.6334567	0.4819414	0	1
Financial Covenant Dummy	0.721306	0.4484321	0	1
Perf. Pricing Dummy	0.5503198	0.4975452	0	1
Term Loan	0.1403568	0.3474153	0	1
Revolver/Line	0.6667789	0.4714442	0	1
Takeover	0.0531807	0.2244315	0	1
Debt Repay.	0.0508246	0.2196764	0	1
EBITDA	0.0875186	0.0865302	-0.9058682	0.3407702
Total Assets	7.371733	1.673136	2.030251	10.84494
Tobin's Average Q	1.811702	1.032384	0.6344355	9.489656
Sales	1.22772	0.7977768	0.0192308	4.420817
Dividends	0.0115696	0.019575	0	0.1539757
Leverage	0.2738354	0.1695324	0.0000247	1.036439
Debt Due In One Year	0.1014618	0.1766776	0	1
Cum. Stock Returns	1.03483	0.1711	0.3562049	2.436053
St. Dev. Stock Returns	0.1078873	0.0653614	0.0041521	0.7240801
Debt Rating	8.831706	7.560972	0	23
Debt Rating Dummy	0.6068664	0.4885283	0	1
N		2971		