TWO ESSAYS ON APPLIED ECONOMICS

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DECLARATION OF ORIGINALITY

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ABSTRACT

Two Essays on Applied Economics

This thesis is composed of two essays on applied economics. In the first, I examine the risk-laden choices of contestants in the TV game show, "Var Mısın Yok Musun?". I had three objectives in exploiting a dataset of 248 contestants: (i) analyzing the path-dependence in choices; (ii) comparing the findings from Turkey with those of the US, the Netherlands, and Germany; (iii) examining the effect of contestants' characteristics on their choices. I find evidence that contestants have time-varying risk aversion. Additionally, I observe greater risk aversion among Turkish contestants. Finally, the odds of accepting an offer are high for females and contestants with high education but low for participants from the Black Sea and Mediterranean regions after controlling demographics and within-game variables. Females are more sensitive to the risk than males.

In the second essay, I develop a static model to examine the relationship between capital misallocation and informality by looking at the effects of exogenous changes in the wealth distribution, capital market imperfection, and tax enforcement. The model predictions are as follows: First, capital misallocation in the formal sector increases as tax enforcement increases due to the flow of informal entrepreneurs into the formal sector. Second, an increase in tax enforcement decreases capital misallocation in the intensive margin but increases it in the extensive margin. Third, as the borrowing constraint is relaxed, capital misallocation decreases. Fourth, the greater the wealth is distributed unequally among entrepreneurs, the greater the extent of capital misallocation. Empirical observations support these predictions.

ÖZET

Uygulamalı Ekonomi Üzerine İki Makale

Bu tez, uygulamalı ekonomi üzerine iki makaleden oluşmaktadır. İlkinde, TV yarışması "Var Mısın Yok Musun"daki yarışmacıların risk içeren tercihlerini incelemekteyim. 248 katılımcıdan oluşan bir veri setini kullanarak üç hedefe ulaşmayı hedeflemekteyim: (i) seçimlerdeki yol bağımlılığını analiz etmek; (ii) Türkiye ile ilgili bulguları ABD, Hollanda ve Almanya ile karşılaştırmak; (iii) yarışmacı profillerinin risk tutumları üzerindeki etkisini incelemek. Yarışmacıların zamanla değişen riskten kaçınma özelliklerine sahip olduklarına dair bulgular elde ettim. Buna ek olarak, Türk yarışmacılar arasında daha fazla riskten kaçınma gözlemledim. Nihai olarak, bir teklifi kabul etme ihtimali, demografik özellikler ve oyun içi değişkenler kontrol edildikten sonra, kadınlar ve yüksek eğitimli yarışmacılar arasında yüksek, fakat Karadeniz ve Akdeniz Bölgelerinden katılan yarışmacılar arasında daha düşük. Kadınların riske duyarlılığı erkeklere kıyasla daha az.

İkinci makalede, servet dağılımında, sermaye piyasasının katılığında ve vergi idaresindeki dışsal değişimlerin etkilerine bakarak sermayenin verimsiz dağılımı ve kayıtdışılık arasındaki ilişkiyi incelemek adına statik bir model geliştirmekteyim. Modelin tahminleri şu şekilde: Birincisi, kayıtdışı girişimcilerin formel girişimcilere katılması nedeniyle vergi idaresinin artması sermayenin dağılımındaki verimsizliği formel sektörde artırıyor. İkincisi, vergi toplama kabiliyetindeki bir artış, önceden formel olan firmalar arasında sermaye dağılımındaki verimsizliğini azaltırken, enformel sektörden gelen yeni katılımcılar etkisiyle formel sektördeki toplam verimsizliği arttırmaktadır.

Üçüncüsü, borçlanma kısıtlaması gevşetildiğinde, sermaye dağılımındaki verimsizlik azalmaktadır. Dördüncüsü, girişimciler arasında servet dağılımındaki eşitsizlik arttıkça sermaye dağılımındaki verimsizlik kapsamı büyümektedir. Ampirik gözlemler bu tahminleri desteklemektedir.

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CHAPTER 1

RISKY CHOICES IN A NATURAL EXPERIMENT: "VAR MISIN YOK MUSUN" TV GAME SHOW

1.1 Introduction

Understanding how risky choices are made is the main focus of this chapter, and it also constitutes an integral part of a wide-ranging part of economics. In this field, there exist a vast body of theories, however empirical testing of them is a difficult task via thought experiments or laboratory experiments with real but small monetary amounts.

The importance of natural experiments, structured as well-defined decision problems, to shed light on economic behavior is heavily emphasized in economics literature. (Metrick, 1995; Berk et al., 1996; Beetsma and Schotman, 2001; Levitt, 2004) Following upon this tradition, this chapter analyzes approximately 1700 risky choices from over 248 contestants (after dropping some observations) in the Turkish version of the TV game show Deal or No Deal, "Var Mısın Yok Musun". This TV show has a special environment. First, the stakes are substantially high.[1] Second, there is no success or failure in the game, meaning that no above-average skill and knowledge is required to finalize the game with a high monetary amount.[2] Third, the tasks are repeated in the same manner under risk in a ceteris paribus environment of each round.

[1]The average amount won in Turkish version is 56,572₺ (41,900$), which was approximately four times per capita annual income in Turkey (between 2007-2010).

[2]Almost everything is deterministic in this environment, even the bank offer is. The structure of the game is well-known by all contestants without any uncertainty, and the monetary amounts in both sealed and unsealed boxes are presented on the screen throughout the game. The deterministic nature of the bank offer will be studied in section 1.4.1.

This study sets out three different goals: (i) analyzing the path-dependence of risk attitudes of contestants; (ii) comparing and contrasting the findings from Turkey — a developing country with considerably different income, wealth and cultural characteristics, to those of developed countries — the United States, the Netherlands, and Germany; (iii) examining the effect of contestants' observable individual characteristics on their ultimate decisions.

Post et al. (2008) pool data from Germany (47), the Netherlands (51) and the US (53), and compares the relevance of both standard expected utility theory and prospect theory to explain the individual choices. Their results suggest that path-dependence is relevance. How does this study differ from Post et. al (2008)? First, I have a richer dataset on a single country which provides me with more degrees of freedom to effectively analyze the time varying risk aversion of contestants. Second, I also have detailed information on individual characteristics which enables me to analyze the role of the individual heterogeneity on risky choices. To achieve the first and second goals presented above, I follow the methodology introduced by Post et al. (2008) in order to safely compare the findings. For the last objective, I conduct both logit and probit analyses with clustered variance under different specifications. Findings support both time-varying risk aversion and relatively high risk averse attitude among Turkish contestants. In addition, the logit regression results reveal that the odds of accepting an offer is high for female contestants and the contestants with high education whereas it is lower for attendees from Black Sea and Mediterranean Regions (compared to Aegean Region) after controlling for a set of demographic and within-game variables. Another significant finding is that

female participants exhibit less risk-sensitive behavior compared to male participants.

The rest of this chapter is arranged as follows. Section 1.2 provides a short review of the literature. Section 1.3 describes the game show. Section 1.4 describes the data and methodologies applied to active each objective presented above. Finally, Section 1.5 concludes.

1.2 Related literature

There exist a vast body of literature consisting of both field as well as laboratory experiments set out to assess individual's risk preferences. However, in many of the laboratory experiments, the selection problem becomes evident as pointed out by Harrison and List (2004). Such experiments generally involve college students because of their proximity to researchers. Field and/or natural experiments, however, eliminate this problem by drawing samples on populations with wider demographics, and provide more representative subject pools. In the latter category, TV game shows have gained popularity among academics. Andersen et al. (2008) provides a detailed and clear review of the use of behavior from television game shows to infer risk attitudes.

Among the game shows documented in Andersen et al. (2008), in particular, various editions of the same game analyzed in this chapter have been studied by a number of researchers. Bombardini and Trebbi (2012), De Roos and Sarafidis (2009), and Mulino et al. (2009) estimate the full dynamic choice model by maximum likelihood method, while Post et al. (2008), Blavatskyy and Pogrebna (2010), Deck, Lee and Reyes (2006) use reduced-form

analyses. Among the former class of studies, for example, De Roos and Sarafidis (2009) confirm the role of individual heterogeneity, find mixed evidence of greater risk aversion by females, and point out the rank-dependent utility model in the Australian version of the game show. In the latter class, Post et al. (2008), the benchmark study of this chapter, pool data from the US, the Netherlands and Germany, and address the important role of reference-dependence decision theories in contrary to the commonly used expected utility theory. They also conduct laboratory experiments with small fractions of the original stakes to isolate the effect of the amounts, and consequently reinforced their conclusion that previous outcomes taken along the path towards making a risky choice affect the ultimate decision of the contestants.

The literature has been mostly centered around the versions of the game aired in developed countries. Although developing countries provide an interesting setting due to the differences in cultural, social and/or economic background of their citizens, the work on these countries is limited. This is the main motivation of this study, and how I would like to contribute to the literature. To the best of my knowledge, it is the first attempt to analyze the Turkish version of "Deal or No Deal".

1.3 Description of the game show

The TV game show was produced by Endemol (a Dutch producer) in 2002, and spread over all around the world in a short span of time. It was first aired in Turkey in September 2007, and won a seat among the most watched TV

broadcasts only in two months, and became the first on 24 November 2007. Although there are slight differences between versions from country to country, the main structure is similar among the set of versions addressed in this chapter.

The contestants play and deal for a top prize of 500,000 Turkish Lira (₺) in a maximum of seven rounds.[3] At each episode, a contestant is confronted with 24 sealed boxes full of varying monetary amounts (ranging from 1₺ to 500,000₺). The monetary amounts in all of the boxes are known at the start of the game, but the exact location of any prize is unknown. First, the contestant randomly picks one box and has right to claim ownership of the hidden amount in it. Next, she has to open a predetermined number of remaining 23 boxes at each round, and reveals the monetary amount inside. The risky part presents itself at the end of each round. An entity known as *"The Banker"* makes a phone call to the contestant and presents an offer of sure monetary amount in exchange for what might be contained in the contestant's chosen box, and yields the floor to the presenter to ask the all-important question of the game — Deal or No Deal?. While accepting ("Deal") the bank offer puts an end to the game, and leaves the contestant with a sure offered amount of money; rejecting ("No Deal") forces her to enter the next round, and again open a predetermined number of boxes which will be followed by a new bank offer. This process of removing boxes and receiving offers stops when either the contestant choose to deal or she receives the prize in her own box upon rejecting all the bank offers. Figure 1 presents the flowchart of the game.

[3]This maximum amount and the rest of the description section applies to the Turkish version.

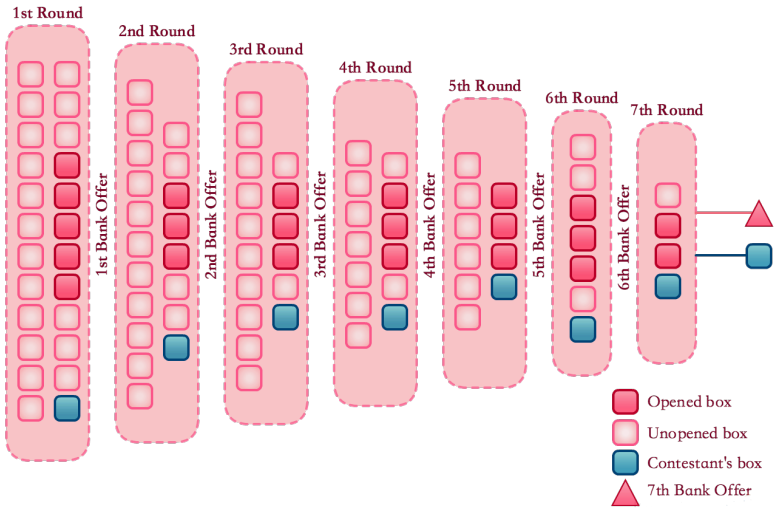


Figure 1. Flowchart of the game

1.4 Data and methodology

The data on Turkish edition is not open to public due to patent related issues, thus it is collected by getting authorization from the Turkish broadcaster to watch each episodes in their offices. Data on the US, Dutch and German editions of the show is obtained from Post et al. (2008). Along with "Deal or No Deal" decisions, the dataset contains information on the opened and unopened boxes/amounts at each round, the bank offers, and some observable individual characteristics like each contestant's legal sex, age, marital status, marriage longevity, number of children, years of schooling and the application region.[4]

[4]Turkey is divided into seven geographical regions -namely Aegean Region, Black Sea Region, Central Anatolia Region, Eastern Anatolia Region, Marmara Region, Mediterranean Region, and Southeastern Anatolia Region- depending on their climate, location, flora and fauna, transportation, topography and agricultural diversities.

The dataset on Turkish edition consists of three seasons with 308 episodes. However, due to the following reasons, I choose to drop some episodes.

I. The first season uses 22 prizes instead of 24 even though both versions are played over maximum of seven game rounds. Consequently, the number of boxes that has to be opened at each round differs. Therefore, pooling episodes with 22 boxes with the ones with 24 boxes would distract the results. (28 observations are dropped).

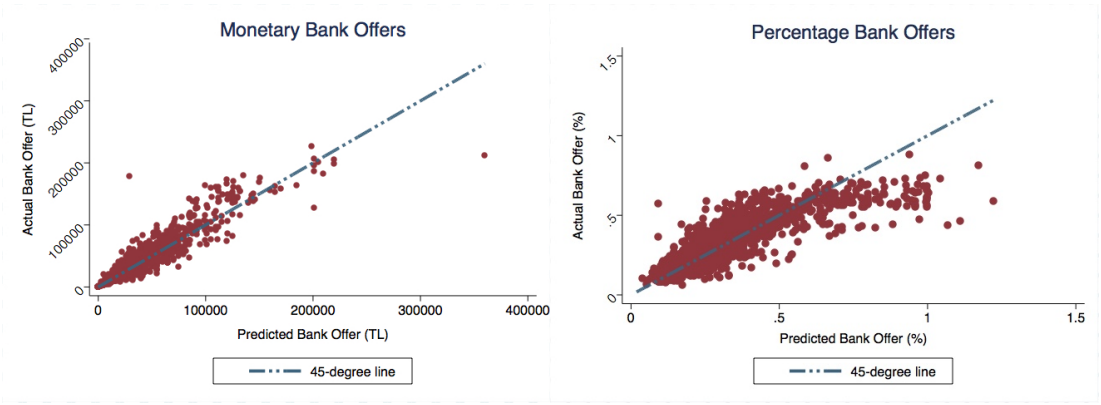
II. In case a contestant reaches the last round with two boxes containing considerably small amounts, either "The Banker" does not want to make an offer or the contestant does not want to receive. In other words, the contestant implicitly rejects the offer without seeing it. Thus, having observations with missing bank offer at the last round would distort the analyses that will be conducted later. (14 observations are dropped).

III. I drop some observations due to episode-specific design of the initial prizes -like a maximum of 1,000,000 TL- or the contestant profile. They are mainly New Year's Eve and celebrity episodes. For example, Adriana Lima was a contestant in one of these celebrity episodes. (11 observations are dropped).

IV. There are also some missing observations due to purely random reasons, arising largely from data-collecting issues. (7 observations are dropped).

1.4.1 Bank behaviour

The banker behaves in a predictable way. First, the offers start at a low percentage of the average remaining prize. Second, the offers exponentially increase towards 70 percent through the end of the game (Table 1). Third, the offers are not informative. The banker does not know the distribution of the prizes over the boxes since an independent notary allocates the prizes into these boxes. Fourth, the offers are known with near-certainty (Figure 2). These are important features since they eliminate the need for controlling some uncertainty related unobservables as well as make reliable cross-country analysis in the upcoming sections.



(a) Monetary Offers (b) Percentage Offers

Figure 2. Actual vs predicted bank offers

Knowing that the offers are not informative, the bank behavior can be modeled such that it depends on the average of the remaining prizes as in Post et al. (2008).

$$B(x_{r+1}) = b_{r+1} \cdot \overline{x}_{r+1} \tag{1}$$

$$b_{r+1} = b_r + (0.7 - b_r) \cdot \rho^{(9-r)} \tag{2}$$

Table 1. Bank Offers and Contestant Decisions

	Unconditional			Deal			No Deal		
Round(s)	BO %	Stakes	No	BO %	Stakes	No	BO %	Stakes	No
				Turkey (N=248)					
1	11	103,596	248	-	-	-	11.21	103,596	248
2	18	108,313	248	-	-	-	17.61	108,313	248
3	24	112,082	248	-	-	-	23.70	112,082	248
4	30	117,096	248	-	-	-	29.96	117,096	248
5	35	122,096	248	34.6	141,659	5	34.97	121,694	243
6	46	120,706	243	48.9	126,667	87	47.14	117,381	156
7	73	102,033	156	67.5	141,598	88	79.54	50,831	68
				Netherlands (N=51)					
1	6	387,867	51	-	-	-	6	387,867	51
2	14	376,664	51	-	-	-	14	376,664	51
3	34	369,070	51	36	409,802	10	33	359,135	41
4	61	348,820	41	69	394,860	11	58	331,939	30
5	77	317,618	30	82	557,680	7	76	244,555	23
6	88	234,868	23	90	237,416	12	87	232,107	11
7	98	243,868	11	104	414,106	6	91	39,582	5
8	96	50,376	5	100	78,401	3	90	8,338	2
9	106	11,253	2	91	17,500	1	120	5,005	1
				Germany (N=47)					
1	8	24,277	27	-	-	-	8	24,277	27
2	15	24,915	47	-	-	-	15	24,915	47
3	34	23,642	47	-	-	-	34	23,642	47
4	46	21,218	47	-	-	-	46	21,218	47
5	59	22,304	47	59	29,976	2	59	21,963	45
6	72	20,557	45	67	48,038	7	73	15,494	38
7	88	15,231	38	85	21,216	5	88	14,324	33
8	98	15,545	33	91	28,8213	10	101	9,776	23
9	103	14,017	23	109	13,925	11	99	14,101	12
				United States (N=53)					
1	11	152,551	53	-	-	-	11	152,551	53
2	21	151,885	53	-	-	-	21	151,885	53
3	36	147,103	53	-	-	-	36	147,103	53
4	50	148,229	53	-	-	-	50	148,299	53
5	62	148,832	53	79	118,517	1	61	150,434	52
6	73	150,549	52	74	139,421	9	73	152,879	43
7	88	15,231	43	91	204,263	15	86	128,416	28
8	92	15,545	28	96	183,917	14	88	44,644	14
9	98	14,017	14	99	53,825	8	97	21,384	6

Notes: Data on the US, Dutch and German editions of the show is obtained from Post et al. (2008). *"BO%"* stands for the percentage bank offer. *"Stakes"* represents the average of the remaining prizes. *"No"* is the number of contestants present at specified round. *"Deal"* section provides the statistics only for contestants who choose to deal while *"No Deal"* section provides statistics for the opposite case.

where $B(x_r)$ is the monetary bank offer that is $(100 * b_r)$ percent of the average of the set of remaining prizes $(\overline{x}_r)$. In addition, $\rho \in [0, 1]$ is the speed of convergence of the percentage bank offer towards 70%, which is one of the observations derived from Table 1. The value of ρ is estimated using non-linear least squares regression analysis, and the resulting estimate is 0.62. The model explains approximately 70% and 90% of the total variation in the percentage offers (Figure 2-b) and the monetary offers (Figure 2-a), respectively.

1.4.2 Cross-country analysis

The game show format is very similar in all editions other than the amounts at stake. At first glance, Table 1 highlights that the contestants in Turkish version start to accept deals at lower percentage of the expected value of the unopened boxes (34.6). This number is 36, 59, and 79 in the Dutch, German and US editions, respectively. The Dutch edition has huge amount of stakes on the table (as can be seen in average amount won section of the Table 2), translating into the fact that the paper loss in any case of misfortune is much larger in this edition than others. This may explain why Dutch contestants seem more risk averse than their American and German counterparts. However, Turkish contestants seem even more risk averse than the Dutch contestants. This helps us conclude that Turkish contestants exhibit significantly greater levels of risk aversion. Table 2 also supports this conclusion by illustrating that both best offer rejected (%) and offer accepted (%) are significantly lower in Turkish edition.

Table 2. Descriptive Statistics

Variable(s)	Means			
	Turkey (N=248)	Netherlands (N=51)	Germany (N=47)	U.S. (N=53)
Age, *in years*	30.82	45.31	36.47	34.98
Female, *female=1*	0.54	0.27	0.34	0.57
Education, *high=1*	0.61	0.55	0.47	0.49
Best offer rejected, %	51.73	55.89	89.07	80.98
Offer accepted, *%*	67.19	76.27	91.79	91.43
Amount won, *own currency*	56,572	227,265	20,603	122,545

Notes: Data on the US, Dutch and German editions of the show is obtained from Post et al. (2008). *Education* is a dummy variable that takes a value of one for contestants with +12 years of schooling. *Best Offer Rejected* stands for the highest percentage bank offer that is rejected by the contestant. *Offer Accepted* is the percentage bank offer accepted by the contestant, or 100 percent for contestants who end up with its own box.

1.4.3 Path-dependency analysis

Time-varying risk aversion is an important phenomenon in the literature on decision making. Behavioral studies have demonstrated that risk attitudes generally exhibit path-dependence. Thaler and Johnson (1990) propose two different effects in explaining the notion of path-dependence in risky choices: namely "the break-even effect" and "the house money effect". The former refers to the willingness to take more risk in order to make up for a prior loss, while the latter is associated with a greater risk appetite after a prior gain. In a recent study, Hytönen et al. (2014) attempt to explore the underlying forces behind these two effects. They use functional magnetic resonance imaging to record the brain activities of subjects. Their findings support the existence of the path-dependence, and provide evidence that the decreasing risk aversion after gains and losses is strongly associated with the activities of the brain processes.

A rough classification might give us some idea about the existence of path-dependence in the data. Let's classify the contestants as loser or winner following Post et. al (2008) but changing the scale due to the high number of contestants in the Turkish data.

The winner category consists of contestants whose average remaining prize after eliminating the largest one (W_r) is among the best one-fifth.

$$W_r = \frac{n_r \cdot \overline{x}_r - x_r^{max}}{n_r - 1}$$

Similarly, the loser category consists of contestants whose average remaining prize after eliminating the lowest one (L_r) is among the worst one-fifth.

$$L_r = \frac{n_r \cdot \overline{x}_r - x_r^{min}}{n_r - 1}$$

where $\overline{x}_r$ is the current average, n_r represents the number of remaining boxes, as well as x_r^{min} and x_r^{max} stands for the minimum and maximum of the remaining prizes, respectively.

Table 3 exhibits the effect of prior outcomes on the contestants' decisions. Both winners and losers (compared to neutral ones), on average, are inclined to continue to play (i.e., exhibiting risk-lover attitude). The "Deal" percentage among both losers and winners is lower than the ones in the neutral category even though the banker offers lower percentages (BO%) to contestants in the neutral category. This finding suggests the existence of break-even and house-money effects, i.e. signals the importance of prior outcomes in the data.

Table 3. Good and Bad Fortune

	Loser			Neutral			Winner		
Round(s)	BO %	No	D %	BO %	No	D %	BO %	No	D %
				Turkey (N=248)					
1	8.24	50	-	9.78	148	-	18.44	50	-
2	13.22	50	-	16.57	148	-	25.12	50	-
3	20.35	50	-	22.93	148	-	29.31	50	-
4	29.08	50	-	28.66	148	-	34.70	50	-
5	41.36	50	-	32.53	148	2.03	35.8	50	4.0
6	61.86	49	20.41	40.89	145	44.14	43.44	49	21.53
7	86.76	31	12.90	66.77	94	72.34	76.82	31	51.61
1-7			4.76			16.93			11.02

Notes: *"BO%"* is the percentage bank offer; *"No"* is the number of contestants; and *"D%"* is the percentage of contestants accepting the bank offer given the game round.

1.4.4 The effect of contestant heterogeneity

This section applies alternative logit regressions with clustered variance to examine whether the contestant's observable characteristics helps us to explain their odds of accepting and rejecting a bank offer.[5] Therefore, the dependent variable is the contestant's "Deal or No Deal" decision (a dummy variable with 1 for "Deal" and 0 otherwise). Table 4 provides the list of explanatory variables, together with their descriptions.

Abs_Rem is the average remaining prize in absolute terms (normalized by 100,000 TL) whereas Rel_Rem is in relative terms (relative to the expected prize at the beginning of the game). Since the tendency to continue to play directly depends on how attractive the bank offer is, Offer is included as a control variable. Additionally, Std_Rem and Med_Rem are included for measuring the riskiness of the decision after receiving an offer. For instance, Std_Rem measures the risk of continuing play and it can be considered as the additional risk associated with per unit of possible gain. App variables are used

[5]Using probit model instead of logit gives similar results.

Table 4. List of Variables and Descriptions

Variables	Descriptions
A. Within-game Variables	
Abs_Rem	Average (Av.) remaining prize/100,00TL
Rel_Rem	Av. remaining prize/Initial average prize
Offer	Bank offer/Av. remaining prize
Std_Rem	Std. dev. of the remaining prizes/Av. remaining prize
Med_Rem	Median of the remaining prizes/Av. remaining prize
B. Individual Specific Variables	
Female	Legal sex of the contestant, dummy (=1 for female)
Age	Age of the contestant
Education	Education level (=1 for +12 years of schooling)
Marital	Marital stat. of the contestant, dummy (=1 for married)
M_longevity	Marriage longevity of the contestant, in years
Children	The number of children that the contestant has
Employment Status Dummies	
Emp1	Retired
Emp2	Private sector employee
Emp3	Public sector employee
Emp4	Self-employed
Emp5	Student
Emp6	Unemployed
Application Region Dummies	
App1	Aegean Region
App2	Black Sea Region
App3	Central Anatolia Region
App4	Eastern Anatolia Region
App5	Marmara Region
App6	Mediterrean Region
App7	Southeastern Anatolia Region

to control both the effect of income and cultural differences across regions.

The estimates can be seen in Table 5. The first column only controls the within-game determinants, and not surprisingly all of them turn out to be significant at 1%, with the expected odds ratios (OR). The OR attached to Offer is not surprisingly high since it is the main variable of interest for the contestants. The significance of the risk measures, Std_Rem and Med_Rem, reveals that contestant's odds of accepting an offer increase with the risk. Finally, the odds of deal also increases with the average of the remaining prizes (in relative terms).[6] It is also intuitive due to the fact that the bank offer directly depends on this average (Section 1.4.1). These results remain robust under all specifications in Table 5.

The third column displays that Female, Education and two of App dummies turn out to be significant at 5%, 5%, 1%, and 1% significance levels, respectively. While the odds of accepting an offer is high for female contestants and the ones with high education, it is lower for attendees from Black Sea and Mediterranean Regions (compared to Aegean Region). Since Age is statistically insignificant even at 10% and highly correlated with Education (with a corr. coeff. 0.77), I drop this variable. The results do not change much (Column 4). Finally, I include two interaction terms, Children×Female and Std_Rem×Female. The former is to capture the differential impact of having children on male and female's choices whereas the latter is to examine the different attitudes of male and female contestants towards risk. The important finding is that female participants are less risk-sensitive.

[6]Controlling Abs_Rem instead of Rel_Rem yields similar results under all specifications in Table 5.

The final model (Column 5) illustrates that Female, App2, and App5, together with within-game variables are statistically significant at 1%; as well as Education and Std_Rem×Female is at 5%.

1.5 Conclusion

This chapter examines the risky choices of contestants in the Turkish version of the TV game show "Deal or No Deal" and compares the findings with the Netherlands, Germany, and the United States versions since they have the same format other than the amounts at stake. The evidence supports both time-varying risk aversion and relatively greater levels of risk aversion among Turkish contestants. The logit analyses reveal that the odds of accepting an offer is high for female contestants and the contestants with high education whereas it is lower for attendees from Black Sea and Mediterranean Regions (compared to Aegean Region) after controlling for a set of demographics as well as within-game variables. In addition, female participants exhibit less risk-sensitive behavior compared to male participants.

Table 5. Alternative Random-Effects Logistic Regression(s)

	[1]		[2]		[3]		[4]		[5]	
	Odds R.	p>|z|	Odds R.	p>|z|	Odds R.	p>|z|	Odds R.	p>|z|	Odds R.	p>|z|
Offer	8459.66	(0.000)**	5409.17	(0.000)**	6414.09	(0.000)**	6376.25	(0.000)**	7354.62	(0.000)**
Rel_Rem	7.32	(0.000)**	6.89	(0.000)**	7.28	(0.000)**	7.23	(0.000)**	7.96	(0.000)**
Std_Rem	34.74	(0.000)**	27.25	(0.000)**	31.75	(0.000)**	31.81	(0.000)**	71.43	(0.000)**
Med_Rem	6.05	(0.000)**	6.18	(0.000)**	6.83	(0.000)**	6.86	(0.000)**	7.77	(0.000)**
Female			1.68	(0.043)*	1.74	(0.028)*	1.63	(0.026)*	11.49	(0.003)**
Age			1.01	(0.745)	1.01	(0.547)				
Education			1.58	(0.038)*	1.61	(0.036)*	1.61	(0.034)*	1.56	(0.049)*
Children			1.07	(0.738)	1.04	(0.848)	1.12	(0.374)	1.27	(0.105)
Children×Female									.69	(0.108)
Std_Rem×Female									.32	(0.029)*
Birth2					.28	(0.005)**	.28	(0.006)**	.24	(0.002)**
Birth3					.63	(0.234)	.63	(0.247)	.61	(0.207)
Birth4					.57	(0.462)	.58	(0.478)	.59	(0.488)
Birth5					.37	(0.000)**	.37	(0.001)**	.35	(0.000)**
Birth6					.52	(0.482)	.52	(0.486)	.51	(0.436)
Birth7					.38	(0.194)	.36	(0.180)	.34	(0.187)
_Constant	4.9e-08	(0.000)	4.5e-07	(0.000)	6.1e-08	(0.000)	8.1e-08	(0.000)	1.8e-08	(0.000)
Goodness-of-Fit Measures										
LL	-364.19		-359.20		-354.19		-354.38		-349.40	
Mc_Fadden R^2	.36		.37		.38		.38		.38	
Cox-Snell R^2	.80		.81		.82		.82		.83	
No. of obs. (clustered)	248		248		248		248		248	

Notes: The table presents the results from the logit regressions of the " Deal/No Deal" decisions of 248 contestants in the Turkish data under different specifications. Together with odds ratios and p-values, the table also reports the number of observations (clustered) as well as some goodness-of-fit measures: log-likelihood (LL), Cox-Snell R-squared, and McFadden's R-squared. ** and * indicate significance at the 1% and 5% levels, respectively.

CHAPTER 2

WEALTH INEQUALITY, INFORMALITY AND CAPITAL MISALLOCATION

2.1 Introduction

How can we explain the per-capita income disparity between developed and developing nations? It is well established in the literature that that differences in total factor productivity (TFP) constitute a dominant source of cross-country differences in the standards of living. (Hall and Jones, 1999; Hsieh and Klenow, 2010; among many others) Given that aggregate output is produced by heterogeneous firms which substantially differ in their productivity levels (Syverson, 2011), one can account for the different levels of aggregate output across countries via looking at the distribution of firm-level productivities and/or how efficient the factor inputs (capital and/or labor) are allocated across production units. During the last few decades, the allocation channel has become the focal point of the growth literature in an attempt to explain the productivity differences both at the national as well as the sector level. There are two different approaches adopted in this strand of literature. Restuccia and Rogerson (2013) label these approaches as either "direct" or "indirect". While the direct approach is after the specific frictions that distort the allocation of factor inputs across producers, the indirect approach tries to quantify the extent of misallocation without looking at the underlying friction.

Due to its relevance for policy making to promote economic growth, a number of recent studies have focused on specific factors that differentially affect producers and distort the allocation of resources among them (e.g., legislation, political connections, corruption, labor market regulations, informational frictions and financial market imperfections). In this study, I solely focus on the extent of capital misallocation, and first document some empirical regularities from a selected set of countries. Then, I develop a static economy framework where financial markets are imperfect and heterogeneous agents sort into different sectors (formal vs. informal) depending on their initial wealth as well as managerial ability levels. Finally, I focus on the theoretically generated effects of exogenous changes in (i) the distribution of wealth, (ii) capital market imperfection (i.e., the tightness of the capital market), and (iii) the level of enforcement that the government imposes on the collection of taxes from informal sector on capital misallocation. The theory implies that the allocation of capital that maximizes output will equate the marginal products of capital (MPKs) across all producers. If it is not the case, the dispersion in the distribution of MPKs across producers is directly and/or indirectly associated with the inefficient allocation of resources. In the model, capital gets misallocated among both formal and informal producers due to wealth heterogeneity. Borrowing constraints imply that the distribution of wealth has an effect on the firm size distribution. On the top of this effect generated by borrowing constraints, varying levels of government tax enforcement also distorts the allocation of capital through its influence on the sector choices of entrepreneurs (extensive margin) and financial repression (intensive margin).

The central predictions of the model are as follows. First, the extent of capital misallocation in formal (informal) sector increases (decreases) as tax enforcement increases due to the flow of informal entrepreneurs into formal sector (i.e., informal sector size decreases). Second, an increase in tax enforcement decreases capital misallocation among incumbents (intensive margin) but increases it due to entrants (extensive margin). The latter effect dominates the former. Third, as borrowing constraint is relaxed, capital misallocation decreases. Fourth, the greater the wealth is distributed unequally among entrepreneurs, the greater the extent of capital misallocation. These predictions are mostly in line with what we observe in the data. The final prediction of the model is that as borrowing constraint is relaxed, both informal sector size and capital misallocation monotonically decreases up to a threshold level, $\bar{\phi}$. After this threshold, there exist a trade-off between informality and the extent of misallocation.

The paper is organized as follows. Section 2.2 reviews the literature. Section 2.3 documents some empirical regularities. Section 2.4 provides a simple motivating example following Restuccia (2013) to document the idea of misallocation. Section 2.5 presents the model and Section 2.6 provides some model-based predictions. Finally, Section 2.7 concludes.

2.2 Related literature

This study is related to the misallocation literature, which seeks to explain the determinants of aggregate productivity by going beyond the technology-based explanations. Motivated by the fact that firms in the same industries often

exhibit very large productivity differences (Syverson, 2011), the studies in the literature proposes that the way resources are allocated among these firms can have substantial effect on aggregate productivity.[7]

One of the seminal works in this line of research is Restuccia and Rogerson (2008), which theoretically generate a sizeable aggregate productivity loss via the introduction of idiosyncratic distortions that are negatively correlated with firm level productivity. Another study is Hsieh and Klenow (2009) which build a monopolistic competition model and apply the idea, put forward by Restuccia and Rogerson (2008), to micro-data on manufacturing establishments to quantify the potential extent of misallocation in China and India relative to the United States. Their findings reveal that both China and India suffer from significant levels of inefficiency in allocating their resources across production units, and moving to US efficiency level would increase their TFPs at around 40% to 60%. Following upon these two seminal works, a number of studies try to explain the causes of resource misallocation and its effect on aggregate productivity. For instance, Buera et. al. (2011), Midrigan and Xu (2013), Moll (2014), and many others quantitatively study the effects of financial frictions and show that these frictions have sizable adverse effects on aggregate TFP.[8] Gopinath et. al. (2017) combine misallocation and financial friction literature and test the hypothesis that the decline in the real interest rates —associated with the introduction of Euro— led to a decline in TFP in Southern Europe through the inefficient allocation of capital inflows towards unproductive firms having high net worth. They find that capital misallocation

[7]Restuccia and Rogerson (2017) provides a detailed and clear survey of the literature.

[8]Please, see Buera, Kaboski and Shin (2015) for a review of the literature on entrepreneurship and financial frictions.

is an important driver of TFP dynamics rather than labor misallocation, and heterogeneous financial frictions are likely cause of this misallocation. David et. al. (2016) study information frictions as another source of misallocation. They provide a framework in which firms face imperfect information when they make their input decisions. In case only capital is chosen under imperfect information, their estimates range from 7% to 10% for productivity loss and 10% to 14% for output loss in China and India. Apart from studying the effects of specific distortions, Bartelsman et al. (2013) contribute to the literature by providing an alternative robust measure —the within-industry covariance between size and productivity— to evaluate the impact of misallocation.

This study is also related to the literature on informality. Informality is prevalent all around the world and poses serious economic and social challenges for policymakers. In the context of misallocation, studying informality is particularly relevant. The reason is twofold. First, a number of studies try to explain developing countries' falling behind their developed counterparts in terms of productivity through the misallocation channel. We well know that informality is a prevailing feature of these countries and generally associated with unproductive production units. Second, the existence of informal sector adversely affects the level of financial development in the economy, which brings additional costs on the formally operated firms since they are the ones who benefited most from the financial markets. There is a vast body of literature which seek to identify the determinants of informality both theoretically and empirically. (Prado, 2011; Ihrig and Moe, 2004; Elgin and Oztunali, 2014; Chong and Gradstein, 2007; among many others) These studies

are mostly cantered around the issues like tax enforcement, trade liberalization, institutional development, labor market imperfections, income inequality and financial development.

There are also recent studies —though not many— bringing these two literatures together (D'Erasmo et al., 2014; Bernabe Lopez-Martin, 2017; and Dias et al. 2016). Among these studies, D'Erasmo et al. (2014) investigate the effect of formal-sector institutions on the size of the informal sector, human capital stock and aggregate productivity. Their main conclusion is that countries with high costs of formalization and a low degree of debt enforcement have larger informal sectors and low allocative efficiency. Dias et al. (2016), motivated by the empirical evidence that the service sector differs from the manufacturing sector as it is characterized by significantly higher degree of resource misallocation, find that labor adjustment costs and grater levels of informality in the service sector account for almost half of this difference. This chapter can be considered as a contribution to this strand of the literature.

2.3 Some empirical facts

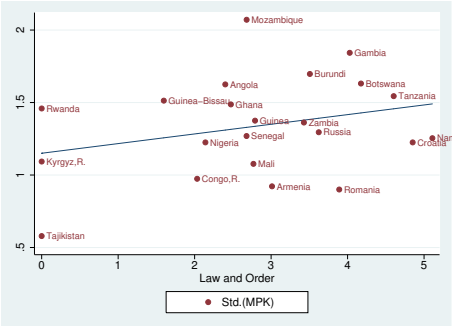
In this section, I use the manufacturing sector dataset from World Bank Enterprise Survey (WBES)[9]. Using the variables as defined in Kalemli-Ozcan and Sorensen (2012) and following Hsieh and Klenow (2009) methodology, I calculate the extent of misallocation across a selected set of countries.[10] Then, I

[9]The data is accessible at https://www.enterprisesurveys.org/data/survey-datasets

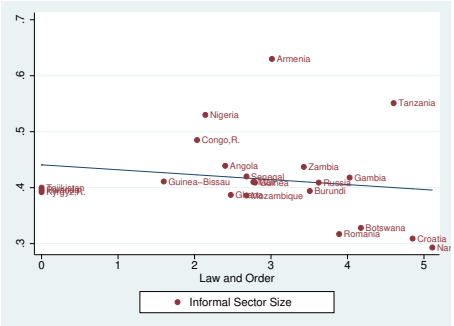
[10]The sample covers 22 underdeveloped and/or developing countries mostly from Africa for which the structure of surveys are identical: Angola, Armenia, Botswana, Burundi, Congo,R., Croatia, Gambia, Ghana, Guinea, Guinea-Bissau, Kyrgyz,R., Mali, Mozambique, Namibia, Nigeria, Romania, Russia, Rwanda, Senegal, Tajikistan, Tanzania, and Zambia. Here, it is important to note that the firm-level observations in the dataset comes from the formal

use Penn World Tables 8.0 and the methodology introduced by Elgin and Oztunali (2012) to estimate the size of the informal sector on the same set of countries. For capital market imperfection, I use the percentage of the firms which identify access to finance as a major constraint. Finally, to proxy tax enforcement, I use an index on law and order (panel averages across countries) following Elgin and Solis-Garcia (2015), which is obtained from the International Country Risk Guide (ICRG). Gini indices are from World Development Indicators of World Bank.

I use simple plots to make some observations in the cross-section. Figure 3-a exhibits a positive relationship between tax enforcement and the extent of capital misallocation while Figure 3-b illustrates that the size of the informal sector is negatively associated with the tax enforcement. At first glance, high levels of capital misallocation at low levels of informality seems surprising. However, we know that there is still no consensus in the literature as to whether informality is either positively, negatively or non-linearly associated with the per capita income levels.



(a) Tax Enforcement vs. Capital Misallocation

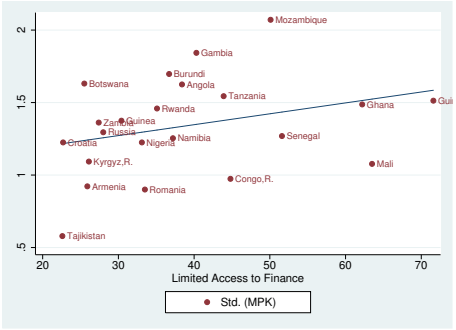


(b) Tax Enforcement vs. Informal Sector Size

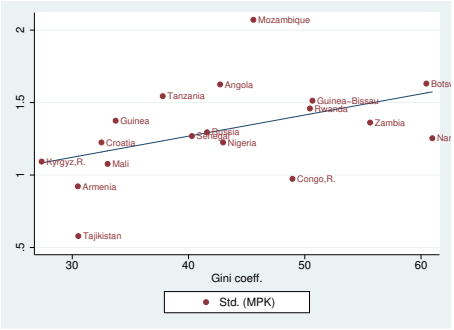
Figure 3. Tax enforcement - capital misallocation - informality

sector.

As it can be seen in Figure 4, the extent of capital misallocation increases together with increasing capital market tightness as well as increasing gini coefficient (i.e., income inequality).[11] In addition, Figure 5 illustrates that as the size of informal sector increases, financing through banks decreases among the selected set of countries.



(a) Access to Finance vs. Capital Misallocation



(b) Income Inequality vs. Capital Misallocation

Figure 4. Finance - capital misallocation - income inequality

Figure 5. Informal sector size vs. financing through bank

[11]Income inequality will be used as a proxy for wealth inequality later while comparing the model predictions with the empirical observation.

2.4 A motivating example

In a simple static economy with firm heterogeneity, there is a single good (taken as numeraire, $p = 1$) produced by firm i according to $y_i = z_i \cdot k_i^{\alpha}$, where y_i is the amount of output produced, z_i is firm-level productivity parameter, k_i is the capital input used by the firm and $\alpha \in (0, 1)$. Firms differ only in their productivity parameters, z_i which is exogenously given. Additionally, capital is supplied inelastically, and total capital endowment equals $\bar{K}$. Given both output and rental prices r, firms optimally choose the amount of capital according to following profit function:

$$\pi_i(z_i; r) = y_i - r \cdot k_i \tag{3}$$

Then, the first order condition implies the following firm-level capital demand:

$$k_i^*(z_i; r) = \kappa \cdot z_i^{1/(1-\alpha)} \tag{4}$$

where $\kappa = \left(\frac{\alpha}{r}\right)^{1/(1-\alpha)}$. Equation (4) implies that $\bar{K}$ should be allocated among firms depending only on their productivity levels such that more productive ones employ more capital, and hence produce more output.

Let's now introduce two idiosyncratic distortions, as in Restuccia and Rogerson (2008) and Hsieh and Klenow (2009), and provide their implications. In this new environment, both profit function and corresponding optimal capital decision rule changes in the following way:

$$\pi_i(z_i, \tau_i^y, \tau_i^k; r) = (1 - \tau_i^y) \cdot y_i - (1 + \tau_i^k) \cdot r \cdot k_i \tag{5}$$

$$k_i^*(z_i; r) = \kappa \cdot \left[\frac{z_i \cdot (1 - \tau_i^y)}{(1 + \tau_i^k)} \right]^{1/(1-\alpha)} \tag{6}$$

Now, consider two firms with identical productivity levels, $z_i = z_j$. In the undistorted economy, both $k_i = k_j$ and $y_i = y_j$ equalities hold whereas they differ due to varying levels of $\zeta_i = \left(\frac{1 - \tau_i^y}{1 + \tau_i^k} \right)$ in this distorted one. It might be the case that productive firms facing high ζ_i are smaller in the presence of distortions than they would be in an undistorted economy, which directly lowers TFP.

In the literature, the extent of capital misallocation is quantified with the standard deviation of the marginal productivities of capital across production units. The intuition is as follows: First, consider the undistorted economy above. The first order condition for the maximization problem in Equation (3) implies that $MPK_i = r$ for all i. Given that r is independent of firm type, there will be no dispersion in the distribution of MPKs across producers — i.e., $var(MPK_i) = var(r) = 0$. However, together with the introduction of idiosyncratic distortions, the first order condition for the maximization problem in Equation (5) leads to the following:

$$MPK_i = r \cdot \left(\frac{1 + \tau_i^k}{1 - \tau_i^y} \right) \tag{7}$$

As a result, $var(MPK_i) = 0$ does not hold unless all producers face the same distortion. In line with this small discussion, the full-fledged model in the next section tries to associate these idiosyncratic distortions with wealth inequality, capital market imperfection and the tax enforcement of the government.

2.5 The model

This section presents a static economy framework which builds upon Antunes, Cavalcanti and Villamil (2008) and Elgin and Uras (2012). The economy is populated by a continuum of agents who are potential entrepreneurs endowed with one unit of time and who differ in their entrepreneurial skill, z_i, as well as their level of initial wealth, ω_i. Ability and wealth holdings are drawn from publicly known distributions with some upper and lower bounds. At the beginning, agents are differentiated depending on their (z_i, ω_i) and invests all their wealth in the capital market. Then, they decide to become either an entrepreneur in the formal or informal sector. Formally operated entrepreneurs have to pay a fixed percentage of output tax, $\tau \in (0, 1)$; but have access to external (uncollateralized) finance in financial markets in the presence of imperfect contract enforceability. On the other hand, informal entrepreneurs are subject to $(\rho \times \tau)$ percentage of output tax, where $\rho \in (0, 1)$ is the tax enforcement parameter reflecting the degree of government's ability to collect taxes from informal sector; and they do not have access to external finance. Therefore, the cost of formalization becomes operating under perfect tax enforcement (i.e., $\rho = 1$) while the benefit is being able to access to external finance through the capital markets. Total labor endowment of the economy is $\bar{N}$, and workers are hired in a competitive labor market.

Production technologies

There is only one good, which is the numeraire and can be produced in two sectors: *formal* and *informal*. $j = f, n$ denotes whether an entrepreneur operates formally (f) or informally (n). An agent, i, produces according to following technology:

$$y_{ij} = z_i \cdot (k_{ij}^{\alpha_j} \cdot n_{ij}^{1-\alpha_j})^{\eta} \tag{8}$$

where k_{ij} and n_{ij} denotes agent i's capital and labor demand, respectively. $\eta \in (0, 1)$ is the Lucas' (1978) span-of-control parameter -i.e. the share of payment going to the variable factors, $\alpha_j \in (0, 1)$ is the share of this payment going to capital, and z_i is the managerial talent of the agent i. It is assumed that $\alpha_f > \alpha_n$, meaning that the production technology is more capital intensive in the formal sector. From now on I will drop the subscripts, i which indexes individuals.

The capital market

All agents put their entire wealth into a financial intermediary and earn the international interest rate, r.[12] Then, they can use this amount as collateral in obtaining loan. The interest rate on the part of the loan that is fully collateralized is r, while the rate on the remainder is $R = r + \zeta$, where

$$\zeta(\nu; \kappa) = \left(\frac{\nu}{1 - \nu} \right) \cdot \kappa$$

[12] A simple small open economy framework with perfect capital mobility.

Following Elgin and Uras (2012), I assume that the government has to collect a given amount of tax revenue from the public. However, it has to rely on indirect taxation through the financial intermediary (financial repression) as the size of the informal sector increases (i.e., tax evasion increases). Therefore, $\zeta(\nu;\kappa)$ is the cost of financial repression, where ν is the endogenously determined fraction of the entrepreneurs who choose to operate in the informal sector and $\kappa > 0$ is a financial repression policy parameter.

Enforcement problems limit the amount of capital rented to formal entrepreneurs, as in Buera, Kaboski and Shin (2011). After production takes place, entrepreneurs may renege on the contracts and can keep fraction $(1-\phi)$ of their profits, where $\phi \in [0,1]$ is the measure of the capital market perfection in enforcing the financial contracts.[13] $\phi = 1$ represents an economy with perfect credit whereas $\phi = 0$ represents an economy with no credit. The latter case is equivalent to the assumption of informal sector's lack of external finance.[14]

Optimal behavior

At first, each agent i puts her entire wealth, ω_i, at a financial intermediary, and makes her sector choice: formal vs. informal operation. Then, both formally and informally operated entrepreneurs choose the optimal amount of factor inputs (labor and capital). In addition, formal ones decide on the optimal amount of uncollateralized loan to finance her firm's capital input (in case they do not have enough internal funds). Upon the allocation of factor inputs across entrepreneurs, production occurs, workers are paid and each formally operated entrepreneur chooses whether or not to renege on their contracts, sequentially.

[13] There exist an upper bound on capital rental which is increasing in z, ω and ϕ.

[14] The empirical observation in Figure 5 supports this assumption.

Informal Entrepreneurs:

For a given level of capital, $\mathbf{k}$, ability, z, and competitive wage rate w, an informally operated entrepreneur solves the following problem to choose the optimal amount of labor input.

$$\max_{n_n} \quad \{z \cdot (1-\rho\tau) \cdot ({\mathbf{k_n}}^{\alpha_n} \cdot n_n^{1-\alpha_n})^{\eta} - w \cdot n_n\} \tag{9}$$

Above maximization problem yields the following optimal labor demand:

$$n_n(\mathbf{k_n}, z; w) = \left\{ \frac{z \cdot (1-\rho\tau) \cdot (1-\alpha_n) \cdot \eta \cdot {\mathbf{k_n}}^{\alpha_n \eta}}{w} \right\}^{\frac{1}{1-\eta(1-\alpha_n)}} \tag{10}$$

Plugging equation (10) into (9) results in the following optimal profit function $\pi_n(\mathbf{k_n}, z; w)$ for given level of capital, $\mathbf{k_n}$, and entrepreneurial skill, z. Wage rate, w will be endogenously determined as a general equilibrium object.

$$\pi_n(\mathbf{k_n}, z; w) = \{1-\eta\cdot(1-\alpha_n)\}\cdot\{z\cdot(1-\rho\tau)\cdot{\mathbf{k_n}}^{\alpha_n\eta}\}^{\frac{1}{1-\eta(1-\alpha_n)}}\cdot\left\{\frac{\eta\cdot(1-\alpha_n)}{w}\right\}^{\frac{\eta(1-\alpha_n)}{1-\eta(1-\alpha_n)}} \tag{11}$$

Informal sector entrepreneur does not have access to external finance, therefore solves the following problem:

$$\begin{aligned} \mathbf{V_n}(\mathbf{k_n}, z, \omega; w) = \max_{\mathbf{k_n} \geq 0} \quad & \{\pi_n(\mathbf{k_n}, z; w) - (1+r) \cdot \mathbf{k_n}\} \\ \text{s.t.} \qquad & \mathbf{k_n} \leq \omega \end{aligned} \tag{12}$$

with an interior solution

$$\mathbf{k_n^u}(z; w) = \left\{ z \cdot (1-\rho\tau) \cdot \left[\frac{\eta \cdot (1-\alpha_n)}{w}\right]^{\eta(1-\alpha_n)} \cdot \left[\frac{\alpha_n \cdot \eta}{1+r}\right]^{1-\eta(1-\alpha_n)} \right\}^{\frac{1}{1-\eta}} \tag{13}$$

This is the optimal capital demand given that the entrepreneur is unconstrained (i.e., $\mathbf{k_n^u} \leq \omega$). Therefore, the optimal capital demand for each entrepreneur operating informally becomes

$$\mathbf{k_n^\star}(z, \omega; w) = \min\{\mathbf{k_n^u}, \omega\} \tag{14}$$

Specifically, for a given ability level, z, entrepreneurs will be unconstrained if their initial wealth, ω exceeds the threshold $\bar{\omega}(z)$ as specified below:

$$\omega \geq \Psi \cdot z^{\frac{1}{1-\eta(1-\alpha_n)}} = \bar{\omega}(z)$$

where $\Psi = \left\{ (1-\rho\tau) \cdot \left[\frac{\eta \cdot (1-\alpha_n)}{w}\right]^{\eta(1-\alpha_n)} \cdot \left[\frac{\alpha_n \cdot \eta}{1+r}\right]^{1-\eta(1-\alpha_n)} \right\}^{\frac{1}{1-\eta}}$

Therefore, profit in informal entrepreneurship takes the following form

$$\pi(\mathbf{k_n^\star}, z; w) = \begin{cases} \{1-\eta\cdot(1-\alpha_n)\} \cdot \{z\cdot(1-\rho\tau)\cdot \mathbf{k_n^u}(z;w)^{\alpha_n \eta}\}^{\frac{1}{1-\eta(1-\alpha_n)}} \cdot \left\{\frac{\eta\cdot(1-\alpha_n)}{w}\right\}^{\frac{\eta(1-\alpha_n)}{1-\eta(1-\alpha_n)}} & \text{if } \omega \geq \bar{\omega}(z) \\ \{1-\eta\cdot(1-\alpha_n)\} \cdot \{z\cdot(1-\rho\tau)\cdot \boldsymbol{\omega}^{\alpha_n \eta}\}^{\frac{1}{1-\eta(1-\alpha_n)}} \cdot \left\{\frac{\eta\cdot(1-\alpha_n)}{w}\right\}^{\frac{\eta(1-\alpha_n)}{1-\eta(1-\alpha_n)}} & \text{if otherwise} \end{cases}$$

Formal Entrepreneurs:

$$\max_{n_f} \quad \{z\cdot(1-\tau)\cdot(\mathbf{k_f}^{\alpha_f}\cdot n_f^{1-\alpha_f})^\eta - w\cdot n_f\} \tag{15}$$

For a given level of capital, $\mathbf{k_n}$, and managerial ability, z, above maximization problem yields the following optimal labor demand:

$$n_f(\mathbf{k_f}, z; w) = \left\{ \frac{z\cdot(1-\tau)\cdot(1-\alpha_f)\cdot\eta\cdot\mathbf{k_f}^{\alpha_f\eta}}{w} \right\}^{\frac{1}{1-\eta(1-\alpha_f)}} \tag{16}$$

Plugging equation (16) into (15) results in the following optimal profit function $\pi_f(\mathbf{k_f}, z; w)$ for given level of capital, $\mathbf{k_f}$, and managerial ability, z.

$$\pi_f(\mathbf{k_f}, z; w) = \{1-\eta\cdot(1-\alpha_f)\}\cdot\{z\cdot(1-\tau)\cdot{\mathbf{k_f}}^{\alpha_f\eta}\}^{\frac{1}{1-\eta(1-\alpha_f)}}\cdot\left\{\frac{\eta\cdot(1-\alpha_f)}{w}\right\}^{\frac{\eta(1-\alpha_f)}{1-\eta(1-\alpha_f)}} \tag{17}$$

Unlike the informally operated ones, formal sector entrepreneurs have access to external finance (i.e., uncollateralized loan). Let $\mathbf{a}$ and $\mathbf{b}$ be the amount of self-financed capital and uncollateralized loan, respectively. $\mathbf{V_f}(\mathbf{a}+\mathbf{b}, z, \omega; w)$ denotes the net profit of (z, ω) type entrepreneur operating in formal sector and described as follows:

$$\begin{aligned} \mathbf{V_f}(\mathbf{a}+\mathbf{b}, z, \omega; w) = \max_{\mathbf{a},\mathbf{b}\geq 0} \quad & \{\pi_f(\mathbf{a}+\mathbf{b}, z; w) - (1+r)\cdot\mathbf{a} - (1+R)\cdot\mathbf{b}\} \\ \text{s.t.} \quad & (1+R)\cdot\mathbf{b} - \phi\cdot\pi_f(\mathbf{a}+\mathbf{b}, z, w) \leq 0 \\ & \mathbf{a} - \omega \leq 0 \end{aligned} \tag{18}$$

While the first constraint guarantees that the entrepreneur will not renege on the contract (incentive compatibility), the second constraint places an upper-bound on the self-financing.

The Lagrangian associated with above problem becomes

$$\begin{aligned} \boldsymbol{\mathcal{L}} = \pi_f(\mathbf{a}+\mathbf{b}, z; w) - (1+r)\cdot\mathbf{a} - (1+R)\cdot\mathbf{b} \\ +\boldsymbol{\lambda_1}\cdot[\phi\cdot\pi_f(\mathbf{a}+\mathbf{b}, z; w) - (1+R)\cdot\mathbf{b}] \\ +\boldsymbol{\lambda_2}\cdot[\omega - \mathbf{a}] \\ +\boldsymbol{\lambda_3}\cdot\mathbf{a} + \boldsymbol{\lambda_4}\cdot\mathbf{b} \end{aligned}$$

Then, the Kuhn-Tucker conditions are

$$\boldsymbol{\mathcal{L}_a} = \pi_{1f}(\mathbf{a}+\mathbf{b}, z; w) - (1+r) + \boldsymbol{\lambda_1} \cdot \phi \cdot \pi_{1f}(\mathbf{a}+\mathbf{b}, z; w) - \boldsymbol{\lambda_2} + \boldsymbol{\lambda_3} = 0 \tag{19}$$

$$\boldsymbol{\mathcal{L}_b} = \pi_{1f}(\mathbf{a}+\mathbf{b}, z; w) - (1+R) + \boldsymbol{\lambda_1} \cdot \{\phi \cdot \pi_{1f}(\mathbf{a}+\mathbf{b}, z; w) - (1+R)\} + \boldsymbol{\lambda_4} = 0 \tag{20}$$

$$\boldsymbol{\lambda_1} \cdot \{\phi \cdot \pi_f(\mathbf{a}+\mathbf{b}, z; w) - (1+R) \cdot \mathbf{b}\} = 0 \tag{21}$$

$$\boldsymbol{\lambda_2} \cdot (\omega - \mathbf{a}) = 0 \tag{22}$$

$$\boldsymbol{\lambda_3} \cdot \mathbf{a} = 0 \tag{23}$$

$$\boldsymbol{\lambda_4} \cdot \mathbf{b} = 0 \tag{24}$$

The eight inequalities are that the four $\boldsymbol{\lambda_i} \geq \mathbf{0}$, and the four constraints are already listed above: incentive compatibility constraint, feasibility constraint, and non-negativity constraints. There are 6 equations for the 6 unknowns $(\mathbf{a}, \mathbf{b}; \boldsymbol{\lambda_1}, \boldsymbol{\lambda_2}, \boldsymbol{\lambda_3}, \boldsymbol{\lambda_4})$ However, only solutions which satisfy the 8 inequalities are admissible.

There are 16 cases of the Kuhn-Tucker conditions, but 12 of them are trivial. The rest is as follows:

- Case 1: Suppose

$$\phi \cdot \pi_f(\mathbf{a}+\mathbf{b}, z; w) - (1+R) \cdot \mathbf{b} > 0 \tag{25}$$

$$\omega - \mathbf{a} > 0 \tag{26}$$

$$\mathbf{a} > 0 \tag{27}$$

$$\mathbf{b} = 0 \tag{28}$$

Equations from (21) to (23) imply that $\boldsymbol{\lambda_1}, \boldsymbol{\lambda_2}, \boldsymbol{\lambda_3} = \mathbf{0}$. Then, by (19) and (20), we have

$$\boldsymbol{\lambda_4} = R - r > 0$$

We know from (28) that the amount of uncollateralized loan is zero, (i.e., $\mathbf{b}(z; w) = 0$). Then, provided that all other constraints are satisfied, we can derive optimal capital demand, $\mathbf{a}(z; w)$, from (19) as follows.

$$\mathbf{a}(z; w) = \left\{ z \cdot (1 - \tau) \cdot \left[\frac{\eta \cdot (1 - \alpha_f)}{w} \right]^{\eta(1-\alpha_f)} \cdot \left[\frac{\alpha_f \cdot \eta}{1 + r} \right]^{1-\eta(1-\alpha_f)} \right\}^{\frac{1}{1-\eta}} \tag{29}$$

- Case 2: Suppose

$$\phi \cdot \pi_f(\mathbf{a} + \mathbf{b}, z; w) - (1 + R) \cdot \mathbf{b} > 0 \tag{30}$$

$$\omega - \mathbf{a} = 0 \tag{31}$$

$$\mathbf{a} > 0 \tag{32}$$

$$\mathbf{b} = 0 \tag{33}$$

Equations (21) and (23) imply that $\boldsymbol{\lambda_1}, \boldsymbol{\lambda_3} = \mathbf{0}$. Then, by (19) and (20), we have

$$\pi_{1f}(\boldsymbol{\omega} - \boldsymbol{\xi}, z; w) = 1 + r + \boldsymbol{\lambda_2} \tag{34}$$

$$\pi_{1f}(\boldsymbol{\omega} - \boldsymbol{\xi}, z; w) = 1 + R - \boldsymbol{\lambda_4} \tag{35}$$

There are two equations and two unknowns, $(\boldsymbol{\lambda_2}, \boldsymbol{\lambda_4})$. Provided that the roots satisfy other constraints, optimal decision rules become $\mathbf{b}(z; w) = 0$ and $\mathbf{a}(z; w) = \omega$.

- Case 3: Suppose

$$\phi \cdot \pi_f(\mathbf{a} + \mathbf{b}, z; w) - (1 + R) \cdot \mathbf{b} > 0 \tag{36}$$

$$\omega - \mathbf{a} = 0 \tag{37}$$

$$\mathbf{a}, \mathbf{b} > 0 \tag{38}$$

Equations (21), (23) and (24) imply that $\boldsymbol{\lambda_1}, \boldsymbol{\lambda_3}, \boldsymbol{\lambda_4} = \mathbf{0}$. Then, by (19) and (20), we have

$$\boldsymbol{\lambda_2} = R - r > 0$$

From equation (37), optimal amount of self-finance capital becomes equal to entrepreneur's initial wealth (i.e., $\mathbf{a}(z; w) = \omega$). We can derive optimal loan demand, $\mathbf{b}(z; w)$, from (19) and (20) such that

$$\mathbf{b}(z; w) = \left\{ z \cdot (1 - \tau) \cdot \left[\frac{\eta \cdot (1 - \alpha_f)}{w} \right]^{\eta(1-\alpha_f)} \cdot \left[\frac{\alpha_f \cdot \eta}{1 + r} \right]^{1-\eta(1-\alpha_f)} \right\}^{\frac{1}{1-\eta}} - \omega \tag{39}$$

provided that other constraint are also satisfied.

- Case 4: Suppose

$$\phi \cdot \pi_f(\mathbf{a} + \mathbf{b}, z; w) - (1 + R) \cdot \mathbf{b} = 0 \tag{40}$$

$$\omega - \mathbf{a} = 0 \tag{41}$$

$$\mathbf{a}, \mathbf{b} > 0 \tag{42}$$

Equations (23) and (24) imply that $\boldsymbol{\lambda_3}, \boldsymbol{\lambda_4} = \mathbf{0}$. Then, by (19) and (20), we have

$$\pi_{1f} \cdot (\mathbf{a} + \mathbf{b}, z; w) \cdot [1 + \phi \cdot \boldsymbol{\lambda_1}] = 1 + r + \boldsymbol{\lambda_2} \tag{43}$$

$$\pi_{1f} \cdot (\mathbf{a} + \mathbf{b}, z; w) \cdot [1 + \phi \boldsymbol{\lambda_1}] = (1 + R) \cdot (1 + \boldsymbol{\lambda_1}) \tag{44}$$

There are four equations and four unknowns, $(\mathbf{a}, \mathbf{b}; \boldsymbol{\lambda_1}, \boldsymbol{\lambda_2})$. Provided that other constraints are satisfied, we can solve for these unknowns.

The intuition behind these four cases is straightforward: An entrepreneur who choose to operate in the formal sector has four different choices:

- Case 1: She can self-finance his optimal amount of capital with some proportion of her initial wealth, and then earn interest from the remaining part.
- Case 2: She can use her entire wealth for self-financing.
- Case 3: She can use her entire wealth for self-financing and obtain external credit to finance his optimal amount of capital without hitting the borrowing constraint.
- Case 4: She can use all her wealth for self-financing and obtain external credit to finance his optimal amount of capital but the amount is constrained due to imperfection in the credit market.

Definition of the equilibrium

- Given w and r, each entrepreneur of type (z, ω) chooses a sector to maximize her utility[15]:

$$u_i(c_i) = \max \{V_f(z, \omega; w), V_n(z, \omega; w)\} + (1 + r) \cdot \omega_i$$

- For N of individuals, $\mathbb{1}_i^f$ and $\mathbb{1}_i^n$ are the indicator functions for formal entrepreneurs and informal entrepreneurs, respectively. Then excess labor supply, N_x, must be sufficiently low.

$$N_x = \sum_{i=1}^{N} \{\bar{N} - \mathbb{1}_i^f \cdot n_{if}(z, \omega; w) - \mathbb{1}_i^n \cdot n_{in}(z, \omega; w)\}$$

  where $n_{in}(z, \omega; w)$ and $n_{if}(z, \omega; w)$ are the policy functions for labor demand of informal and formal entrepreneurs, respectively.

2.6 Model simulations

This study does not have any claim about the determinants of the distribution of wealth. However, one of the objectives of this study is to examine the effects of an exogenous change in it. Therefore, I take wealth and ability distributions as exogenous. To the extent that they are positively correlated, starting with two source of heterogeneity (wealth and ability) seems implausible. Therefore, wealth and ability are drawn from negatively correlated distributions with a correlation coefficient -0.77 (Figure 6).

[15]Entrepreneurs are risk-neutral having a linear utility function as $u_i(c_i) = c_i$. Upon collection of net returns from production and the bank deposits, they consume.

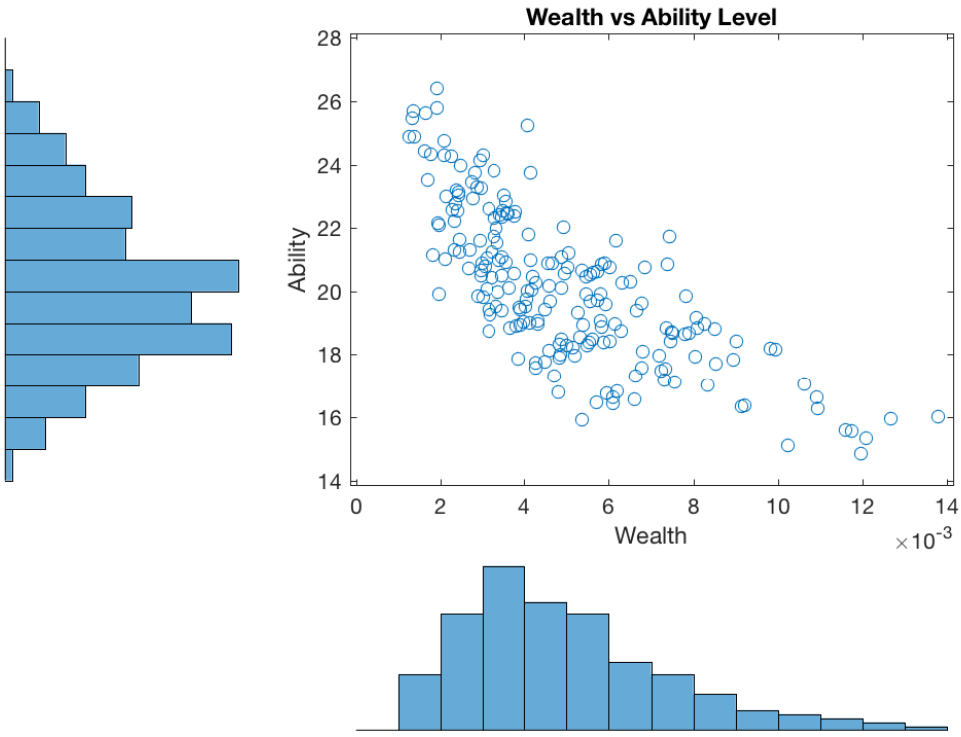


Figure 6. Wealth vs. ability distribution, (N=200, corr. =-0.77)

The effect of tax enforcement (ρ)

In this section, I use a grid with 20 values for the tax enforcement together with the parameter values presented in Table 6 to theoretically quantify the size of the informal sector, the extent of capital misallocation in the formal sector, informal sector and aggregate economy under three different specifications of ϕ.

Table 6. Model Parameters

Parameter	Value	Description
α_f	0.45	Formal sector capital share
α_n	0.40	Inormal sector capital share
η	0.90	Lucas' span-of-control parameter
τ	0.35	Tax rate
κ	0.25	Financial repression policy parameter
r	0.25	Exogenous interest rate

In a distortion-free economy with perfect capital markets, there should be no heterogeneity in the rate of returns on capital across entrepreneurs. In our framework, only distortion in the formal sector is the borrowing constraint (i.e. $\phi < 1$). Given that capital markets are perfect (i.e., $\phi = 1$), Figure 7 reveals that at each level of tax enforcement — even though varying levels of informal sector size and the cost of external borrowing — the standard deviation of the marginal product of capital is close to the sufficiently low $\varepsilon = 3 \times 10^{-5}$, meaning that the marginal products of capital (MPKs) across all producers in the formal sector are equated as the standard theory suggests. However, the story is different for informally operated entrepreneurs since they do not have access to external finance, but are constrained with their initial wealth. As the level of tax enforcement increases, unconstrained informal entrepreneurs prefer to stay informal whereas the constrained ones move towards the formal sector. Because of this sector shift, the share of constrained entrepreneurs in the informal sector decreases, lessening the degree of informal sector capital misallocation (Figure 7).

Figure 8 and 9 illustrate that capital misallocation in the formal sector becomes evident when borrowing constraint binds, meaning that the rates of return on capital start varying across entrepreneurs. They also exhibit that the degree of capital misallocation is greater when the tightness of the capital market is higher (i.e., as ϕ decreases). In fact, this finding is in line with the empirical observation presented in Figure 4-a.

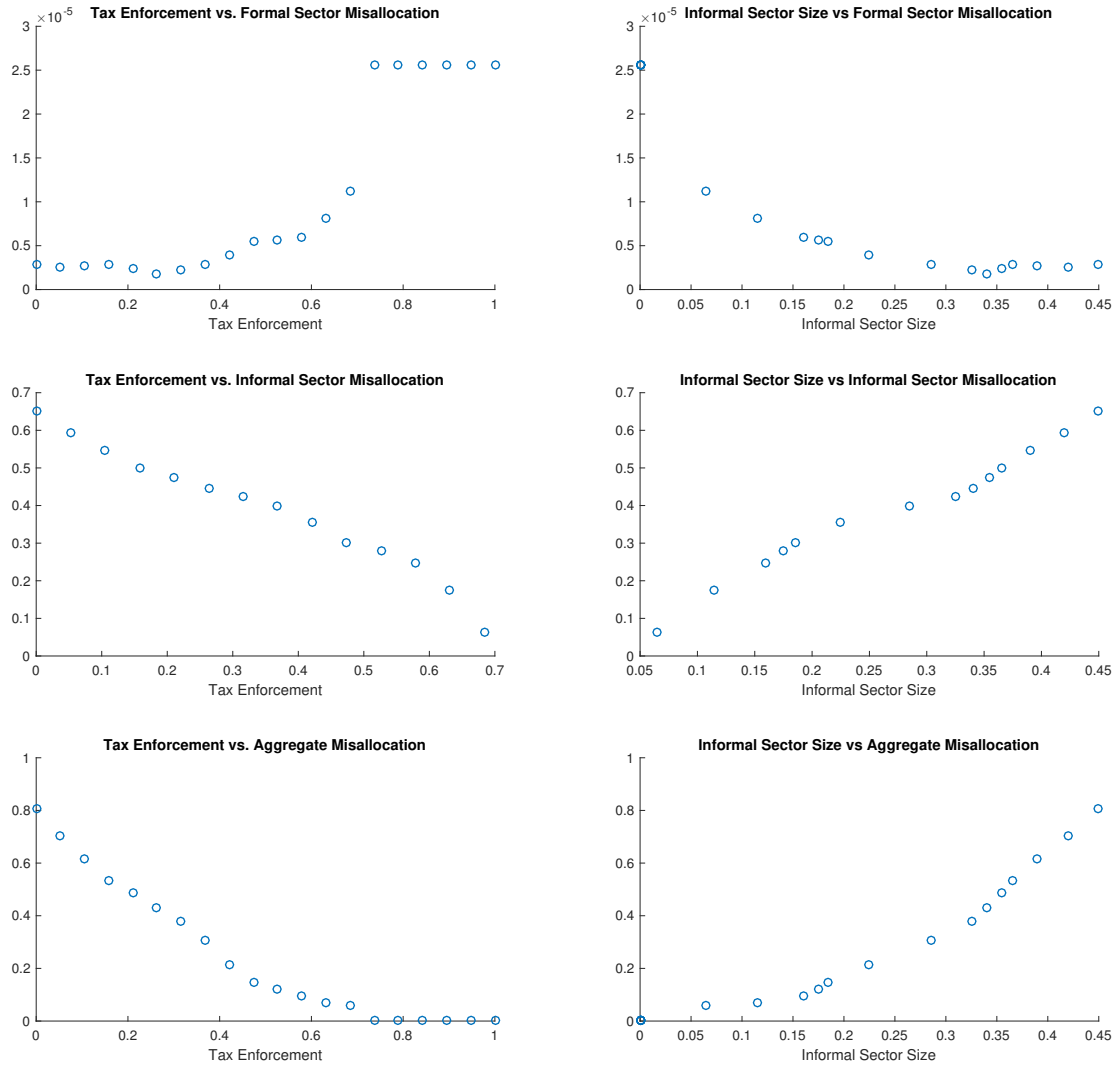


Figure 7. Perfect capital markets, $\phi = 1$

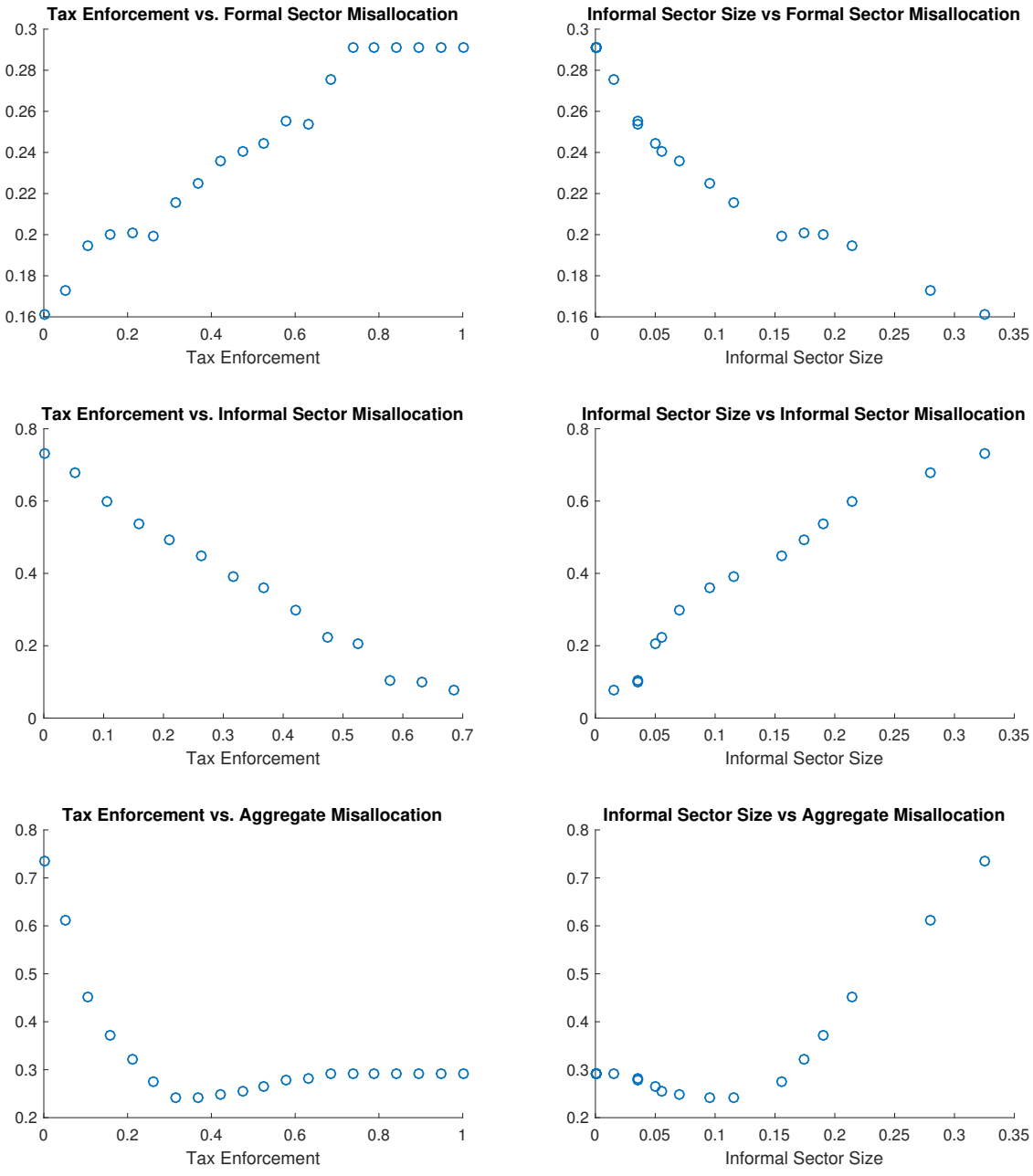


Figure 8. Imperfect capital markets, $\phi = 0.5$

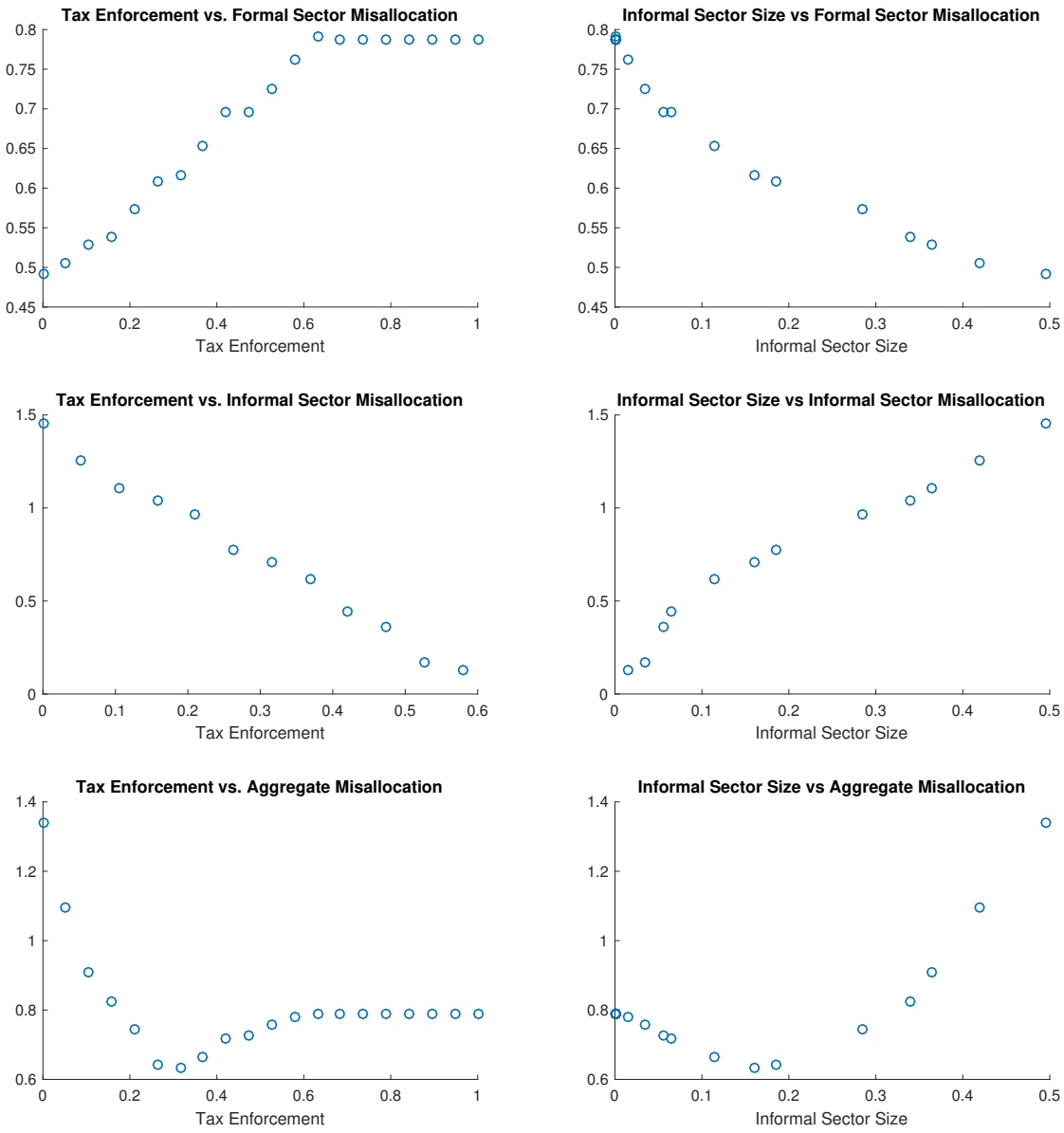
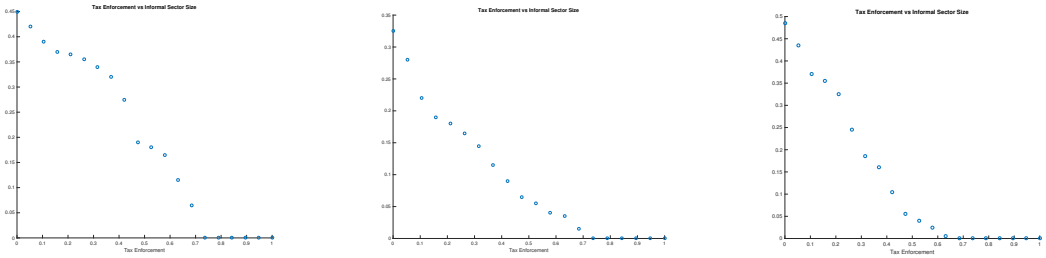


Figure 9. Imperfect capital markets, $\phi = 0.25$

Not surprisingly, Figure 10 exhibits that informal sector size, given ϕ, monotonically decreases as the tax enforcement increases. This prediction of the model is also supported by the empirical finding in Figure 3-b. However, a closer look at these three panels reveals that, given a tax enforcement level, informal sector size changes in a non-monotonic way in response to changing level of ϕ. I will discuss this in the next section.

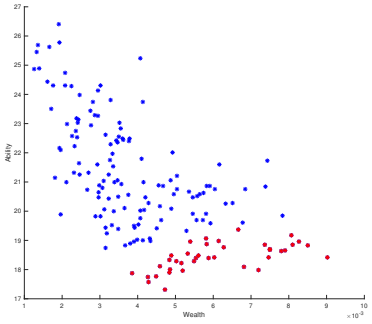


(a) $\phi = 1$ (b) $\phi = 0.5$ (c) $\phi = 0.25$

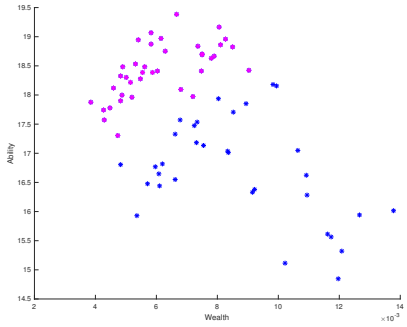
Figure 10. Tax enforcement vs. informal sector size

Figure 11 exhibits the flow of informally operated entrepreneurs into formal sector because of increasing level of tax enforcement for given ϕ. As it can be seen from the same figure, the replacing entrepreneurs were from the upper-tail of the ability but lower-tail of the wealth distribution in the informal sector. It means that the constrained entrepreneurs in the informal sector choose to move towards formal sector as the cost of staying informal increases. This finding supports our above explanation for why capital misallocation in the informal sector decreases along with increasing level of tax enforcement.

The case of formal sector is different. Figure 9 illustrates that capital misallocation in the formal sector increases as tax enforcement increases which is in line with the empirical observation in Figure 3-a. To examine this prediction closely, I decompose the formal sector entrepreneurs (after the policy



(a) Inflows Toward Formal Sector



(b) Outflows From Informal Sector

Figure 11. Increase in tax enforcement $\rho = 0.15$ vs. $\rho = 0.30$, $\phi = 0.25$

change) as either incumbents or entrants. Figure 11-a exhibits that the entrants stand in the upper-tail of the wealth but lower-tail of the ability distribution in the formal sector, which enlarges the range of the wealth and ability distribution in the formal sector and translates into greater level of capital misallocation. However, Table 7 reveals that the policy change decreases the extent of capital misallocation among the incumbent firms. The explanation is straightforward: as the tax enforcement increases the size of the informal sector decreases, which dampens the financial repression. The external cost of borrowing decrease in line with the decrease in financial repression, which relaxes the borrowing constraint. Again Table 7 illustrates that this explanation is also valid for $\phi = 0.5$. The effect of ρ is lessened since the size of the informal sector is already low due to high level of ϕ, which decreases the number of firms flowing into the formal sector in response to the increase in ρ. Overall, Figure 9 accompanied with Table 7 documents that the effect in the extensive margin dominates that of in the intensive margin.

Table 7. Formal Sector Misallocation (Intensive vs. Extensive Margin)

	Incumbents	Incumbents + Entrants
Case I: $\phi = 0.25$		
$\rho = 0.15$	0.54	-
$\rho = 0.30$	0.47	0.62
Case II: $\phi = 0.5$		
$\rho = 0.15$	0.20	-
$\rho = 0.30$	0.18	0.22

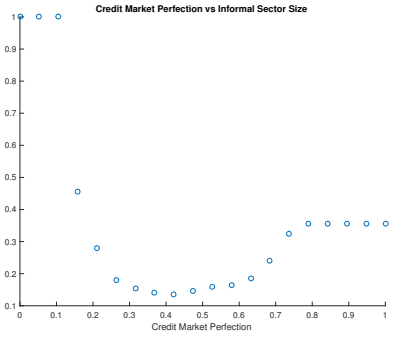
Finally, Figure 7 exhibits that economy-wide misallocation of capital decreases as tax enforcement increases given perfect capital markets. However, as the capital market becomes tighter, it follows a non-linear pattern (as can be seen in Figures 9 and 10) depending on which sector dominates the other.

The effect of capital market perfection (ϕ)

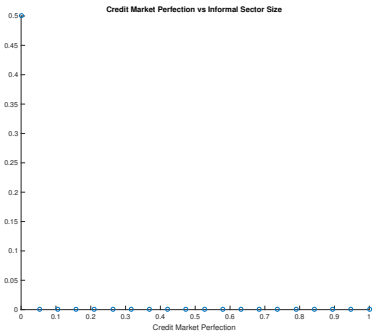
The rate of return to capital is a function of the Lagrange multiplier (λ_1) associated with the borrowing constraint in Equation (18). Since this multiplier varies across entrepreneurs depending on the distribution of the initial wealth, borrowing constraints generate heterogeneity in the rates of return to capital, and thus misallocation of capital across entrepreneurs. The model provides some predictions regarding this relationship.

First, Figure 12-a exhibits the relationship between capital market perfection and informal sector size. As the tightness of the capital market decreases (ϕ increases), entrepreneurs initially move from informal sector to formal sector. However, there exist a threshold (let denote by $\bar{\phi}$) after which some formal sector entrepreneurs move towards informal sector. This non-monotonic relationship is originated from *the general equilibrium effect*. As borrowing constraint is relaxed, the number of unconstrained entrepreneurs

decreases in the formal sector and their capital as well as labor demand increases. Therefore, equilibrium wage starts to increase (as can be seen in Figure 13), pushing the formal firms in the lower-tail of the ability distribution towards informal sector after $\bar{\phi}$. However, the story is different when $\rho = 1$ (Figure 12-b). Informality disappears provided that $\phi > 0$, meaning that the interaction between tax enforcement and capital market perfection plays an important role in shaping the size of the informal sector. Supporting this conclusion, unlike Figure 15, Figure 14 exhibits that as borrowing constraint is relaxed, both the size of the informal sector and capital misallocation monotonically decreases up to a threshold level, $\bar{\phi}$. After this threshold, there exist a trade-off between informality and the extent of capital misallocation.



(a) $\rho = 0.25$



(b) $\rho = 1$

Figure 12. Capital market perfection vs. informal sector size

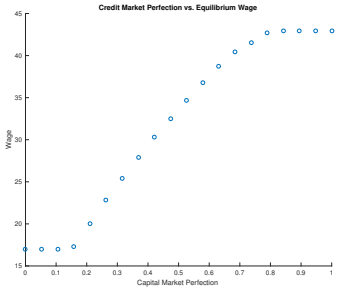


Figure 13. Capital market perfection vs. equilibrium wage, $\rho = 0.25$

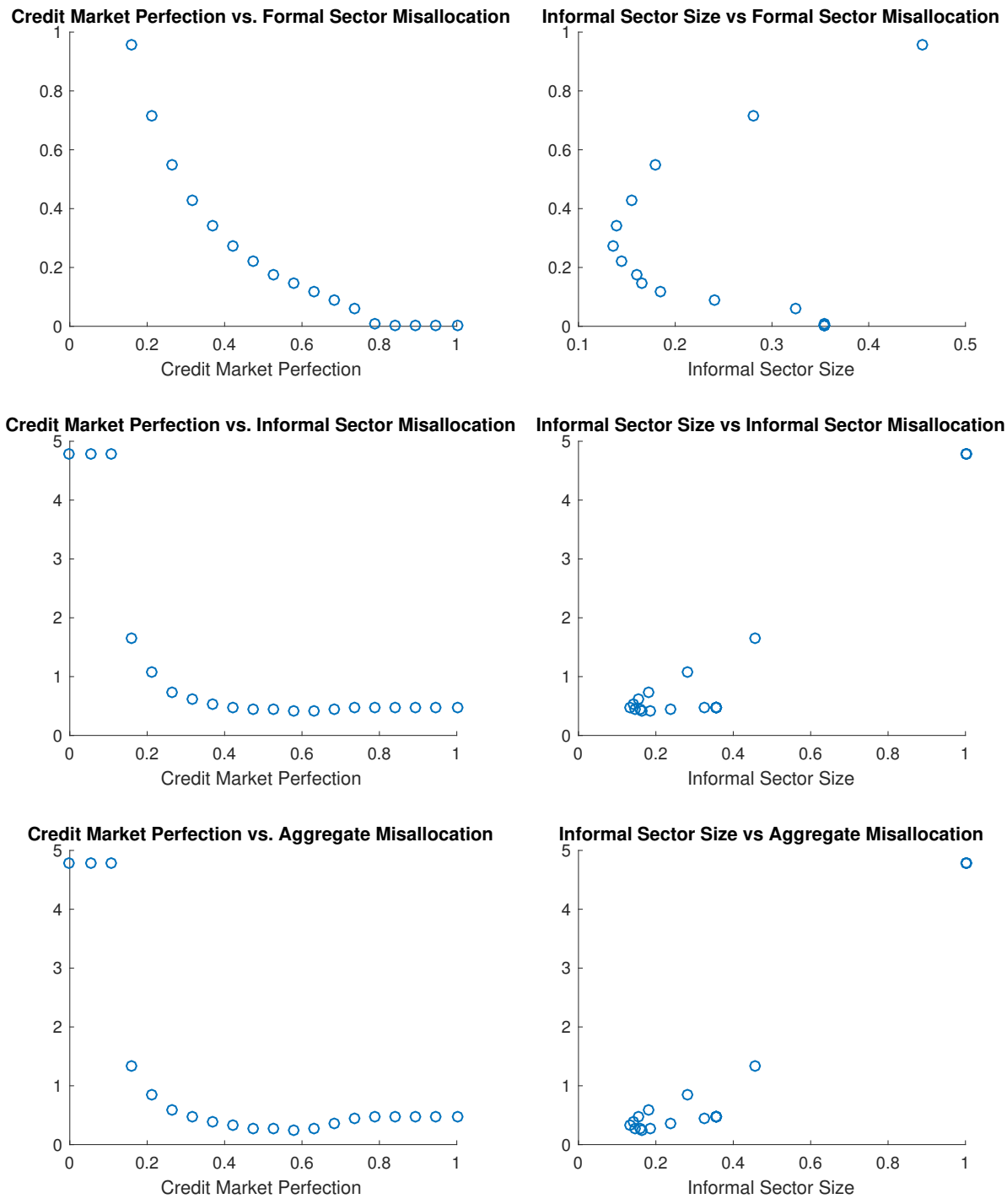


Figure 14. Imperfect tax enforcement, $\rho = 0.25$

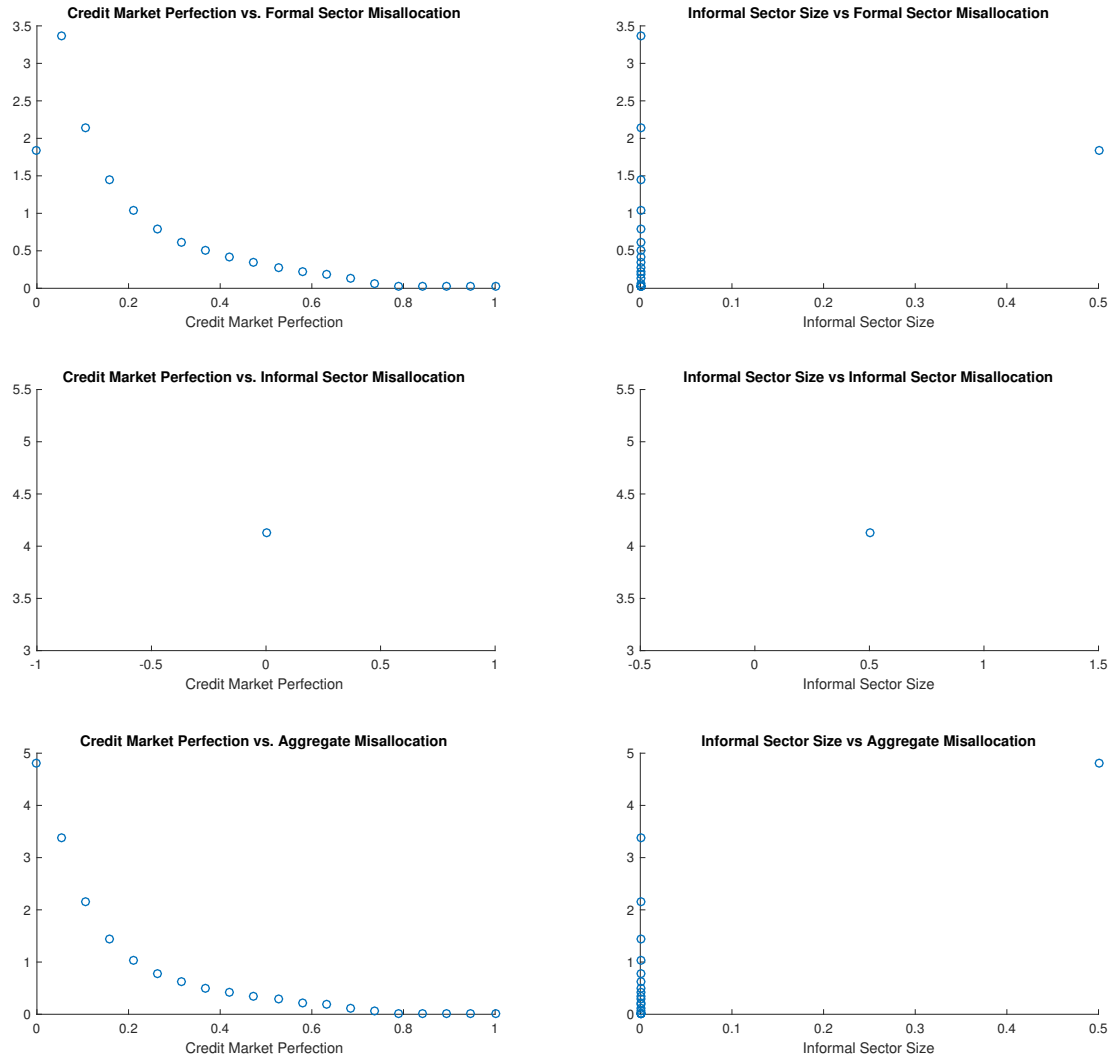


Figure 15. Imperfect tax enforcement, $\rho = 1$

Unlike the effect of tax enforcement, Table 8 reveals that the effect of relaxing borrowing constraint in the intensive margin dominates that of in the extensive margin. In other words, as ϕ increases the entrants cannot increase the capital misallocation in the formal sector.

Table 8. Formal Sector Misallocation (Intensive vs. Extensive Margin)

	Incumbents	Incumbents + Entrants
Case: $\rho = 0.25$		
$\phi = 0.15$	0.92	-
$\phi = 0.40$	0.10	0.27

The effect of wealth inequality

In this section, I study the effects of a mean-preserving decrease in wealth inequality. I specifically asked two questions: How does the degree of capital misallocation change in response to decreased wealth inequality? Does it exacerbate or lessen the effect of tax enforcement on the extent of capital misallocation? To this end, I regenerate the distributions of ability and wealth by holding both the correlation coefficient and mean constant. (Figure 16)

Table 9 illustrates that for all tax enforcement and capital perfection levels, the degree of misallocation decreases. By mapping wealth to income inequality, this prediction of the model coincides with the empirical finding in Figure 4-b. In addition, the same table illustrates that an increase in ρ from 0.15 to 0.30, decreases capital misallocation in the intensive margin approximately 10% vs. 13%; and increases capital misallocation in the extensive margin approximately 20% vs. 15% in equal and unequal cases, respectively.

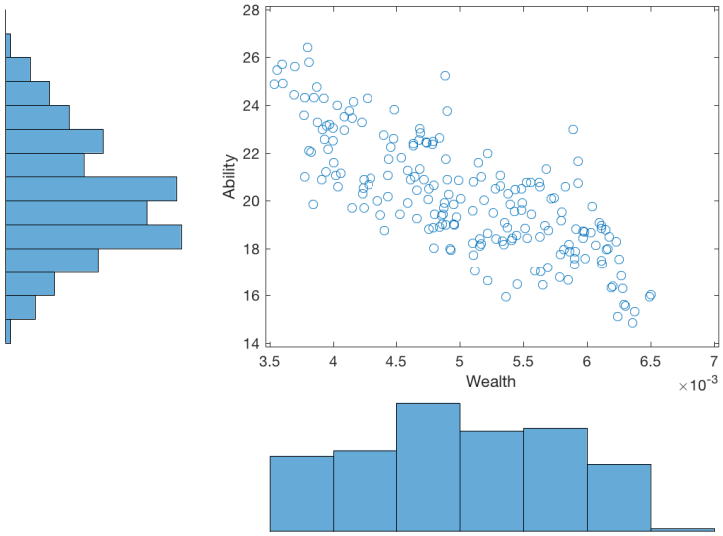


Figure 16. Wealth vs. ability distribution, (N=200, corr. =-0.77)

Table 9. Formal Sector Misallocation (Equal vs. Unequal Wealth Distribution)

	Incumbents	Incumbents + Entrants
Unequal distribution ($\phi = 0.25$)		
$\rho = 0.15$	0.54	-
$\rho = 0.30$	0.47	0.62
Equal distribution ($\phi = 0.25$)		
$\rho = 0.15$	0.43	-
$\rho = 0.30$	0.39	0.52

2.7 Conclusion

This study aims to contribute to the strand of literature which lies in the intersection of misallocation and informality literatures by focusing on the effects of exogenous changes in (i) the distribution of wealth, (ii) capital market imperfection (i.e., the tightness of the capital market), and (iii) the level of enforcement that the government imposes on the collection of taxes from informal sector on both informal sector size and the extent of misallocation

capital misallocation. First, I present some empirical regularities between the main variables of interest through simple plots. Then, I develop a static model where financial markets are imperfect and heterogeneous agents sort into different sectors (formal vs. informal) depending on their initial wealth as well as managerial ability levels. While the cost of informal operation is the inability to access external finance, the advantage is the tax evasion thanks to the government's imperfect tax enforcement. The central predictions of the model are as follows. First, the extent of capital misallocation in formal (informal) sector increases (decreases) as tax enforcement increases due to the flow of informal entrepreneurs into formal entrepreneurs (i.e., informal sector size decreases). Second, an increase in tax enforcement decreases capital misallocation among incumbents (intensive margin) but increases it due to entrants (extensive margin). The latter effect dominates the former. Third, as borrowing constraint is relaxed, capital misallocation decreases. Fourth, the greater the wealth is distributed unequally among entrepreneurs, the greater the extent of capital misallocation. These predictions are mostly in line with what we observe in the data. The final prediction of the model is that as borrowing constraint is relaxed, both informal sector size and capital misallocation monotonically decreases up to a threshold level, $\bar{\phi}$. After this threshold, there exist a trade-off between informality and the extent of misallocation. Unfortunately, I am unable to match this prediction with the data.

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