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A framework for investigating new firm entry: The (limited) overlap between informal-formal and necessity-opportunity entrepreneurship

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ABSTRACT

We analyse entrepreneurial entry along the dimensions of informal-formal and necessity-opportunity entrepreneurship, distinguishing between them yet considering them jointly. While the dominant view in the literature conflates necessity with informal entry, and opportunity with formal entry, we hypothesise that informal entrepreneurship may be attractive to higher-income individuals as a testing ground for entrepreneurial ideas. We also explain why higher-income individuals may undertake necessity entrepreneurship. We utilise individual Global Entrepreneurship Monitor (GEM) data from Chile (2019–2021), which identifies informal-formal and necessity-opportunity entrepreneurial entry modes, to test hypotheses on the role of individuals' income in the four types of entrepreneurial entry. We also consider changes in entrepreneurial entry during a crisis and a non-crisis periods. Our results confirm that the patterns in the data are consistent with hypotheses derived from our proposed theoretical framework.

Executive summary: Emerging markets economies have very large informal sectors, and their entrepreneurial entry is often motivated by economic necessity rather than by business opportunity. But neither informal nor necessity entrepreneurship are usually expected to generate the positive benefits for growth and development predicted for formal and opportunity entrepreneurship. We argue that the dominant stream in the literature actually conflates informal and necessity entrepreneurship, both of which have been associated with low human and financial capital and productivity. We propose that the appropriate typology is more complex than this because there are examples of successful and dynamic informal firms. This leads us to identify four categories of entrepreneurial entry: informal-necessity (Type 1), formal-opportunity (Type 2), informal-opportunity (Type 3), and formal-necessity (Type 4). While necessity entrepreneurship has typically been associated with low-income individuals, we propose that formal-necessity entrepreneurship may be an entry path for both low- and high-income individuals, though for different reasons. Informal opportunity entry may likewise be an option for people with low-income as well as high-income.

We therefore seek to disentangle the analysis of opportunity-necessity and of formal-informal entry and to demonstrate that the two less explored entry modes - informal-opportunity, and

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formal-necessity - are of considerable theoretical and practical significance in emerging economies. We test our framework in the emerging market economy setting of Chile, one of the more prosperous and open economies in Latin America. We use Global Entrepreneurship Monitor (GEM) data which uniquely for Chile allow us to distinguish between individuals along both the formal-informal and the necessity-opportunity dimensions. On this basis, we distinguish empirically between these four categories of entrepreneurial entry and explain how higher-income individuals may use informal-opportunity entrepreneurial entry as a "seed bed" to test their new business ideas. At the same time, we show that necessity entrepreneurship may be attractive to both lower- and higher-income individuals.

We also show that the interplay between individuals' income groups and four entrepreneurial entry modes is stable over "normal times" versus "crisis periods". We observe that in response to a crisis, individuals with lower-incomes are likely to engage more in informal-necessity entrepreneurship while opportunity-informal entry by higher-income individuals will decline. These changes represent a more complex adjustment pattern than has been identified for developed economies, where entrepreneurial activity has been found to be countercyclical. Thus, in emerging markets, informal-necessity entrepreneurship plays a stabilizing role for those individuals with a more marginal position in the labor market during the crisis. In contrast, for those individuals who have access to higher household income, all forms of entrepreneurship become a less attractive option. We interpret this as indicating that these individuals have the option to wait for higher return opportunities to re-emerge. This is one of the first papers to explore the impact of the COVID-19 pandemic on entrepreneurship in an emerging market economy.

1. Introduction

Emerging market economies are characterised not only by widespread entry to the informal sector (Bruton et al., 2012; Salvi et al., 2022), but also by entrepreneurial entry resulting from economic necessity (Caliendo and Kritikos, 2010; Gibbs et al., 2014; Fairlie and Fossen, 2020). Both these characteristics have important implications for national economic performance and welfare (Acs, 2006; Baumol, 1990; Welter et al., 2017; O'Donnell et al., 2024) given that they are not expected to generate the positive benefits for growth and development that are predicted for formal and opportunity entrepreneurship (Estrin et al., 2019; Fredström et al., 2021). As observed by Williams (2011), the dominant literature's conflation of informal and necessity entrepreneurship (Godfrey, 2011; Gibbs et al., 2014) is consistent with a tradition that goes back to the concept of "dual economy", in which informal-necessity businesses are interpreted as backward organisational structures expected to disappear as economic development advances (Lewis, 1954; Webb et al., 2009; Godfrey, 2011). Both informal and necessity entrepreneurship have also been associated with low human and financial capital and productivity (Naude, 2010; Imas et al., 2012; Leporati et al., 2021; Dencker et al., 2021).

However, this tradition has been questioned. In particular, Maloney (2004) argues that the informal sector is more than 'a residual comprised of disadvantaged workers rationed out of good jobs' (Ibid., p.1159), a view for which Falco and Haywood (2016) provide empirical evidence. Ault and Spicer (2022) build on Loayza (2016) in distinguishing between "informal growth-oriented" and "informal persistence-oriented" businesses. Yet hardly any studies have considered formal-informal alongside opportunity-necessity entrepreneurial entry (Gibbs et al., 2014). Our theory is developed by building upon these intuitions and the (limited) overlap between informal-formal entrepreneurship and necessity-opportunity entrepreneurship. This leads us to identify four categories of entrepreneurial entry: informal-necessity (Type 1), formal-opportunity (Type 2), informal-opportunity (Type 3), and formal-necessity (Type 4). We know relatively little about why entrepreneurs may engage in the last two (less common but potentially important) forms of entry, especially the formal-necessity combination. Günther and Launov (2012) discuss the informal-opportunity category, proposing an indirect method to identify it for established informal businesses, but they do not cover the formal-necessity category. Similarly, Williams (2011) discusses the necessity-opportunity contrast within the informal sector but not within the formal sector.

To consider why individuals engage in these four types of entrepreneurial entry, we utilise elements of the theory of opportunity cost and its application to occupational choice, paying particular attention to the individual's income at the time of the entrepreneurial entry decision-making. While the informal sector and necessity entrepreneurship are typically associated with low-income individuals, we propose that the formal-necessity and informal-opportunity entry paths to entrepreneurship may be taken by high-income individuals. We therefore seek to disentangle the analysis of opportunity-necessity from that of formal-informal entry, and demonstrate that the two less explored entry modes—informal-opportunity and formal-necessity—are of considerable theoretical and practical significance. Our research, therefore, *theorises the four types of entrepreneurial entry* and *examines how the decision-making of individuals between the four categories of entrepreneurial entry is influenced by their opportunity cost, as indicated by income.*

We test our proposed framework in the emerging market economy setting of Chile (Aguinis et al., 2020). Although Chile is one of the more prosperous and open economies in Latin America,[1] it represents an emerging market with a challenging societal, political, and economic environment, which is also characterised by a large informal sector (Macpherson et al., 2021). We use Global

[1] In recent decades, Chile has ranked top in Latin America and within the top 15 worldwide economies in terms of attractiveness for doing business. This is based on, among other things, favorable economic trends and an entrepreneurial culture (Amorós et al., 2020).

Entrepreneurship Monitor (GEM) data for Chile, which allow us to distinguish between individuals along the formal-informal and necessity-opportunity dimensions. Our results confirm that the patterns in the data are consistent with the hypotheses derived from our theoretical framework.

In terms of contributions, our study is the first to consider the propensity for entrepreneurial entry utilising a four-way categorisation of informal-necessity, formal-opportunity, informal-opportunity, and formal-necessity (Gibbs et al., 2014; Dencker et al., 2021; Salvi et al., 2022). Our analysis builds on occupational choice theory (Blanchflower and Oswald, 1998; Parker, 2018a, 2018b) in that we employ the economic concept of opportunity cost as indicated by an individual's income. Moreover, we extend the dynamic aspects of the entrepreneurial occupational choice theory (Blau et al., 1956; Nagler, 2015) by explaining how higher-income individuals may use informal-opportunity entrepreneurial entry as a "seed bed" in which to test new business ideas. At the same time, we show that formal-necessity entrepreneurship may be attractive to higher-income individuals.

Furthermore, we verify whether the relationship between individuals´ income groups and the four entrepreneurial entry modes is stable over "normal times" versus "crisis periods". We observe that in response to a crisis, lower-income individuals are likely to engage more in informal-necessity entrepreneurship. In contrast, informal-opportunity entry by higher-income individuals will decline. This represents an adjustment pattern that is more complex than the pattern identified for developed economies where entrepreneurial activity is countercyclical (Wennekers and Thurik, 1999; Koellinger and Roy Thurik, 2012; Fairlie, 2013; González-Pernía et al., 2018). Thus, in emerging markets, informal-necessity entrepreneurship plays a stabilizing role for individuals whose position in the labour market during the crisis is more marginal (McEntire, 2021). This contrasts with individuals who have access to higher household income, to whom all forms of entrepreneurship become a less attractive option during times of crisis. We interpret this as indicating that the more affluent have the option of waiting for higher return opportunities to re-emerge. Finally, this is one of the first papers to explore the impact of the COVID-19 pandemic on entrepreneurship in an emerging market economy.

2. Theoretical foundations

2.1. Types of entrepreneurial entry

We analyse the different types of entrepreneurial entry in emerging economies, overlaying the distinction between formal versus informal entry with the distinction between necessity versus opportunity entrepreneurship. Our analysis is, like our use of the terms "formal" and "informal", limited to pre-launch decisions, although such terms can also apply to issues such as post-launch internal governance (Godfrey, 2011).

In developed economies, most new ventures are formal in the sense that their entry conforms with national legislation and rules for registration. But even in these contexts there is often an informal sector comprising unregistered businesses (see for example La Porta and Shleifer, 2014; Gibbs et al., 2014; Sutter et al., 2017), that 'fail to adhere to the established institutional rules or are denied their protection' (Feige, 1990, p. 990). Informality is, however, especially common in emerging economies (De Soto, 1989), with estimates suggesting that informal ventures may comprise up to 80 % of enterprises in many developing countries (Narula, 2020). Parallel to this, there are significant numbers of individuals who select entrepreneurship as a career choice because they do not have sufficiently attractive alternative employment options (Estrin et al., 2019). According to Fairlie and Fossen (2020), the 'basic distinction is that some entrepreneurs create businesses when they see a business opportunity while other entrepreneurs are forced into starting a business out of necessity because of the lack of other options in the labour market' (Ibid., p.253; see also Dencker et al., 2021; O'Donnell et al., 2024). While the formal versus informal, and the necessity versus opportunity distinctions appear to be conceptually distinct, the dominant strand in the entrepreneurship literature tends to conflate them, linking necessity entrepreneurship with informality, and opportunity entrepreneurship with formality (Williams, 2011; Godfrey, 2011). This is because informality is often argued to be associated with attempts to avoid the high costs of registering entrepreneurial firms; such costs are felt especially keenly by individuals whose lack of alternatives have pushed them into entrepreneurship. Conversely, the individuals who are attracted to entrepreneurship by market opportunities are typically expected to register their firms so as to benefit from the legal protections offered by formality and also, perhaps, to engage in lucrative contracts with state-owned or foreign firms.

These two categories of entrepreneurial entry—informal-necessity and formal-opportunity—have therefore, separately and jointly, received the bulk of theoretical consideration in the literature. There are a few discussions of opportunity entrepreneurship that is informal (e.g., Maloney, 2004) or of necessity entrepreneurship that is formal (Gibbs et al., 2014) but the literature has not previously considered the four possibilities as a whole, let alone analysed their determinants jointly. Our first objective in this paper is to present a typology of entrepreneurial entry comprising four categories: informal-necessity (Type 1), formal-opportunity (Type 2), informal-opportunity (Type 3), and formal-necessity (Type 4). Our attention will focus on the last two categories, which have had much less attention from previous researchers. Our second objective is to apply the theory of occupational choice to consider how the choice between the four different types of entrepreneurial entry is affected by income, a topic we address in the remainder of this section.

2.2. Occupational choice approach applied to entrepreneurial entry

The economic theory of occupational choice (e.g., Parker, 2018a, 2018b) proposes that an individual's propensity to engage in entrepreneurship is driven by an evaluation of the returns on such activity in comparison with their opportunity cost (Blanchflower and Oswald, 1998). The actual or potential benefits and costs are usually *financial* in nature; for example, the expected earnings from entrepreneurship are compared with those from paid employment. Individuals choose entrepreneurship when the expected financial benefits exceed the (opportunity) costs. This naturally leads to a consideration of the types of entry that may be chosen by those who

are better-off versus those who are less well-off, given their different opportunity costs.

Our analysis starts with the key elements of costs and returns that are relevant to the occupational choice of becoming an entrepreneur relative to the next best alternative, usually paid employment (Parker, 2018a), but we extend the logic by applying it to different types of entrepreneurial entry. On the cost side, research has concentrated on financial expenditure and the time spent on establishing an entrepreneurial business, both of which will be higher for formal entrepreneurship (Djankov et al., 2002). Entry into the informal sector implies that the entrepreneur does not have to pay the legal or time costs of registration. Hence, individuals will be more likely to select formal entrepreneurship when they perceive that the set-up costs are lower (Estrin et al., 2019), perhaps because of stronger institutions (North, 1990; Baumol, 1990) or a reduction in corruption (Portes and Haller, 2005).

Much of the work on the benefit side of entrepreneurial entry relates to how the returns to entrepreneurship are defined by market opportunities; entrepreneurs are "pulled" by the alluring potential benefits of entrepreneurial entry. This contrasts with necessity entrepreneurship, in which entrepreneurs are "pushed" by the lack of alternatives in the job market (O'Donnell et al., 2024). The benefits from market opportunities are conditioned for each individual by their educational and human capital (Dencker et al., 2021), as well as by their capacity to cope with uncertainty (Lucas, 1978; Van Praag, 2005). The ability to exploit market opportunities will also be amplified when entrepreneurs have access to financial resources, and this is more typical for those who are better off economically; for example, they may own assets that can serve as collateral in the capital market (Parker, 2018b; Blanchflower and Oswald, 1998). In developed economies, entrepreneurs typically combine self-finance with loans (Gartner et al., 2012) but in emerging economies, access to both may be restricted (Banerjee and Newman, 1993; Korosteleva and Mickiewicz, 2011). This is especially true for lower-income individuals; hence, individuals' evaluation of the benefits of entrepreneurial opportunities may be conditioned by their resources accumulated through earlier income flows (Gibbs et al., 2014). As we will discuss in Section 3, the developing and emerging market context is important for our theorising because we draw upon the theme of financial constraints to motivate our hypotheses; this theme has been introduced into occupational choice theory by Banerjee and Newman (1993).

2.3. Income groups and entrepreneurial entry

In emerging markets, individuals can become entrepreneurs in either the formal or the informal sector. The literature suggests that the informal sector might not be an attractive form of entry for better-off individuals with more human capital (Imas et al., 2012). This is because being in the informal sector usually implies either tax or regulatory avoidance, meaning that enterprises have to stay small to remain below the government radar (La Porta and Shleifer, 2014; Narula, 2020). This, as well as other factors such as exclusion from governmental or foreign firms' contracts, limits the potential gains from entrepreneurship in the informal sector (Sutter et al., 2017).

Even so, there may still be situations in which high-income entrepreneurs use informal entry. These arise because the lower set-up costs provide a mechanism for entrepreneurs to explore business possibilities without fully committing to the costs implied by formal entry. Thus, the informal sector may play the role of a testing ground of entrepreneurial ideas which, if successful, can later be transferred to the formal sector. However, such individuals will typically have higher levels of financial resources at their disposal because if the venture proves profitable, they will need resources to exploit the opportunities; this implies that they predominantly have higher incomes. In economic terms, entrepreneurial entry into the informal sector allows individuals to reduce the (sunk) costs of entry, encouraging its use as a proving ground by people who have the resources to explore new but potentially risky opportunities.

We next turn to the strand of the literature in which entrepreneurship motives are dichotomised into opportunity and necessity factors. Here, we propose that the spectrum of non-necessity motives is wider than that normally envisaged by the narrow definition of opportunity-seeking (Stephan et al., 2015). In this, we follow Yang et al. (2020: 5) who interpret opportunity entry as: "opportunity motivated entrepreneurship implies individuals start businesses because of some motivation 'pull', such as income and wealth, recognition, or independence." Further, Block et al. (2015) reconcile the distinction between necessity and opportunity entry with the opportunity cost concept. They define necessity entrepreneurs as those for whom the opportunity cost of entrepreneurial entry is exceptionally low. However, the notion of opportunity cost is always individual and necessarily subjective (Buchanan, 1969). Opportunity cost, as perceived by a person choosing entrepreneurship, is therefore conditional on their traits, choice set, and preferences. This subjectivity carries over to the concept of necessity. Our approach is consistent with O'Donnell et al. (2021) who, unlike Dencker et al. (2021), argue that "necessity" should not only be interpreted as a need for survival, in which people are pushed into self-employment purely to meet their most basic needs. Even in the least developed countries, individuals face a considerably wider range of options. Moreover, even higher-income individuals may see themselves as necessity entrepreneurs, perhaps because they find themselves having to utilise their financial assets and human capital in an entrepreneurial venture to support their chosen lifestyle.

Will such individuals be more likely to consider a formal or an informal entry mode? As noted in the previous section, entry into the formal sector comes with a higher financial and time cost threshold, imposed by the requirement to comply with regulations. This, however, makes scaling-up easier. Better-endowed individuals, even if they are necessity entrepreneurs, are more likely to be able to finance the cost of formal entry, which allows for higher long-term returns. Furthermore, because their market entry is out of necessity, they will be less likely to quit, at least in the short run. This leads them to "lock themselves in" financially by incurring the higher costs of formal entrepreneurial entry. Therefore, we expect that the choice of formal-necessity entrepreneurship is more likely for higher-income individuals than for those with lower incomes.

3. Hypotheses

Building on the previous section, we apply occupational choice theory to consider differences in the potential entrepreneurial returns and opportunity costs across income groups for entrepreneurial entry as a whole, and then for each element of our four-way

typology. This approach enables us to deduce sharper and better-motivated predictions about the impact of income on the different types of entrepreneurial entry.

In general, the balance of costs and benefits of engaging in entrepreneurial entry is ambiguous for both higher and lower-income groups. For higher-income individuals, we can only clearly say that entrepreneurship is more likely to be chosen as an occupation by those who successfully identify highly profitable opportunities for exploiting their talents via an entrepreneurial route (Shane, 2000). We have noted that higher-income individuals will be more easily able to generate greater entrepreneurial returns because they can relax the (financial) liquidity constraints when exploiting market opportunities. However they will also typically have a higher opportunity cost of entrepreneurship because their forgone earnings are greater. The comparison with lower-income individuals is ambiguous because although their opportunity cost of entrepreneurship will be lower (they will forgo less from paid employment), their potential returns from entrepreneurship will also be lower because they will typically have less human capital as well as a lower ability to obtain external funding. This latter effect will be amplified in emerging economies due to the presence of financial constraints (Banerjee and Newman, 1993). Thus, it is difficult to discern the general impact of income group on entrepreneurial entry; however, distinguishing the four types of entrepreneurship entry helps diminish this ambiguity.

3.1. Entrepreneurial entry: informal-necessity (Type 1)

Prior empirical research in emerging economies has shown that informal entry is concentrated within the poorest socioeconomic status (low-income individuals) and is mainly necessity-driven (Williams and Nadin, 2010a, 2010b; Siqueira et al., 2016). According to Maloney (2004) and Dencker et al. (2021), women and low-skilled individuals are also disproportionately represented among informal-necessity entrepreneurs. Webb et al. (2009) explain that the low-skilled are characterised by lack of capital and more often rely on informal loans. They may also utilise their social linkages to access equipment and other resources that would otherwise be out of their financial reach. However, to secure such informal social cooperation, the entrepreneur has 'to engage adequately with other group members' (Ibid.: 502). In other words, securing the strong social linkages that substitute access to formal resources with informal resources based on voluntary cooperation requires time-consuming social strategies and social investment into acquiring the relevant group identity (Webb et al., 2009). Utilising the occupational choice theory, we may immediately observe that the opportunity cost of time will be lower for the less affluent. They will therefore be more inclined to engage in social activities to forge the strong social linkages needed for accessing resources in the informal sector. This suggests that the opportunity cost to enter informal-necessity entrepreneurship will be lower for lower-income than for higher-income groups.

A parallel argument that utilises occupational choice theory concerns the issue of investment in relation to the role played by the distribution of income and wealth in occupational decisions (Banerjee and Newman, 1993). Income and wealth have a critical impact on the level of investment, especially under the capital market constraints that are typical of emerging market economies (Nagler, 2015). This observation applies directly to the formal and opportunity types of entrepreneurship entry, which both come with investment requirements albeit for different reasons. Investment is required to meet the legal costs of formal entry, and opportunity-based entry is likely to require investment to realise the newly identified opportunities. Thus, both opportunity entry and formal entry are less likely for the less affluent, which implies that these individuals engage in informal-necessity type of entry.

A final argument is based directly on the opportunity cost of sacrificing current consumption, which is higher for the poor. Investment implies intertemporal substitution: a shift from current towards future consumption. However, time discounting is stronger for those located in the lower part of the income distribution (Epper et al., 2020), so the opportunity cost of the required investment is higher, and it is this that makes low-income individuals more inclined to follow the informal type of entry, and less likely to follow the opportunity and formal types of entry that require more intensive financial investment. This leads us to propose:

***H1**. Lower-income individuals will be more likely than higher-income individuals to engage in informal-necessity entrepreneurial entry.*

3.2. Entrepreneurial entry: formal-opportunity (Type 2)

Formal entry is attractive for opportunity-based entrepreneurs because it avoids the restrictions on scale and growth implied by the informal path. Indeed, much discussion of opportunity entrepreneurship in the entrepreneurship literature takes it for granted that the new firm will be registered (Baumol, 1990; Reynolds et al., 2005; Alvarez and Barney, 2007).

Formal, opportunity-driven entrepreneurship can also be viewed from the perspective of the occupational choice theory. As we have argued, the opportunity cost of entrepreneurial entry is greater for higher-income individuals than for those with lower incomes because of their differential returns on the labour market. However, higher-income individuals potentially have greater resources through which they can exploit the opportunities more fully and cover the initial cost of formalisation; not only is the opportunity cost of investing lower for them, so is their time discounting rate (Epper et al., 2020). Thus, formal-opportunity entrepreneurial entry is typically made by individuals whose resources position them to achieve an increase in personal income by exploiting new business opportunities to create a profitable business.[2] Higher-income individuals are better placed to afford the investment needed for the formalisation and realisation of opportunities, and they are better able to bear the associated risks. Based on these arguments, we propose that the opportunity cost to enter formal entrepreneurship for exploitation of a business opportunity will be lower for high-

[2] In a seminal paper based on occupational choice theory, Banerjee and Newman (1993) argue that in an economy with high initial income inequality and constrained capital markets, this feature of the rich making even more money through entrepreneurship ultimately undermines the development process. However, these long-term dynamic macroeconomic implications of the micro phenomena are beyond the scope of this paper.

income than for low-income groups. This is a corollary of the argument we relied upon to support Hypothesis 1. It leads us to propose:

H2*. Higher-income individuals will be more likely than lower-income individuals to engage in formal-opportunity entrepreneurial entry.*

3.3. Entrepreneurial entry: informal-opportunity (Type 3)

There is evidence that informal entrepreneurs in emerging economies engage in both necessity-based and opportunity-driven entrepreneurship (Maloney, 2004; Gibbs et al., 2014). Williams and Nadin (2010b) show that different socioeconomic groups have distinct approaches to informal entrepreneurial activities. They find that informal entry is polarised at two ends of the income spectrum: in the poorest areas, it is a survival mechanism (low-income individuals motivated by necessity), whereas for the more affluent households, it is a testbed for exploring attractive new venture ideas (high-income individuals motivated by opportunity).

What might lead more affluent individuals with opportunity projects to choose informal instead of formal entry? Here, one may conceptualise occupational choice as a *process*, during which individuals acquire new information that in turn affects and potentially modifies their subsequent choices (Blau et al., 1956). Blau et al. (1956) theorise occupational choice as driven by a combination of the relative valuation of the net rewards associated with different alternatives, and an assessment of the likelihood of being able to realise each alternative, with the latter element likely being modified by ongoing occupational experience. Applying this intuition to the question at hand, we note that higher-income individuals may regard engagement in informal-opportunity entrepreneurship as a transitory phase (Williams and Nadin, 2011; Gibbs et al., 2014; Santos et al., 2021; Salvi et al., 2022). In particular, higher-income groups may choose to enter informal-opportunity entrepreneurship to test their business ideas; they can learn about the business opportunity in a market that has lower entry costs than the formal market (González-Pernía et al., 2018; Amorós et al., 2020; Guerrero and Yañez-Valdes, 2023). At the same time, their opportunity cost of accepting the risks associated with opportunity-based projects is lower, given that the more affluent households can handle risk better and have more propensity for financial risk taking (Kruger et al., 2017).

Thus, affluent entrepreneurs may choose the low-cost route of informal entrepreneurship to gain information about the probability of realising the initially perceived opportunity. If their experience leads them to believe that they are likely to make a success of the opportunity, they can switch to the formal sector, which will in turn facilitate scaling up and the realisation of the full gamut of gains. Otherwise, they will quit, having sunk a lower amount. Based on these arguments, we propose that higher-income individuals with opportunity projects characterised by a high degree of risk will enter informal-opportunity entrepreneurship:

H3*. Higher-income individuals will be more likely than lower-income individuals to engage in informal-opportunity entrepreneurial entry.*

3.4. Entrepreneurial entry: formal-necessity (Type 4)

Necessity entry represents a significant proportion of entrepreneurship in emerging economies (Desai, 2011; Salvi et al., 2022). Yet, we have already observed that the combination of necessity-driven motivation and the registration of new ventures is viewed as uncommon (Desai, 2011; Williams and Nadin, 2011; Siqueira et al., 2016). However, we can again use the processual framework of occupational choice (Blau et al., 1956; Nagel, 2015) to argue that this path of entry will be more likely for high-income versus low-income individuals.

It is useful to contrast this case with the informal-opportunity case just discussed. We argued that in the informal-opportunity case, entrepreneurs could face initial risk related to the value of the opportunities they identified, which could make the option of a low sunk-cost informal entry attractive, especially when this is seen as a transitory phase. However, in the case of necessity entrepreneurship, risk is a less relevant factor and, given the low opportunity cost of other income-earning alternatives, the entrepreneur is not considering the option of discontinuing their project. The only benefit to informal entrepreneurship in such cases is its lack of entry costs. As already argued, these come with lower opportunity costs for high-income individuals compared with low-income individuals. Hence, an entrepreneur who can afford the sunk costs of formal entry may find it more attractive to choose the formal path from the outset because it comes with the possibility of future gains from wider market access. Moreover, if entry by an affluent entrepreneur is driven by necessity, their resulting higher level of commitment will make the formal path even more attractive because the formalisation costs will be expected to be spread over a longer time. Finally, the opportunity-necessity distinction relates to the time of making the decision to engage in a start-up. However, in line with the arguments about new opportunities emerging during the entrepreneurial process (Alvarez and Barney, 2007, 2020), the anticipation of these, which high-income individuals have the financial means to realise, will make the formal path more attractive still for higher-income individuals, even if their initial motivation is related to necessity.

These arguments suggest that the opportunity cost to enter formal-necessity entrepreneurship will be lower for higher-income than for lower-income groups. Hence, we propose:

H4*. Higher-income individuals will be more likely than lower-income individuals to engage in formal-necessity entrepreneurial entry.*

3.5. Proposed framework for types of entrepreneurial entry

Fig. 1 summarises the proposed theoretical framework, in which motivation for entry (necessity or opportunity) intersects with mode of entry (formal or informal).

4. Sample, data, and methods

4.1. Sample

We test the hypotheses on the association of income with four types of entrepreneurial entry using the GEM Chilean Adult Population Survey data obtained from annual surveys implemented in 2019, 2020, and 2021. Unusually, this dataset distinguishes between registered (formal) and unregistered (informal) entrepreneurial activities, and it contains location identifiers. The surveys also capture a period of low growth before the pandemic crisis (2019), a period of deep crisis (2020), and a post-recovery period (2021).[3] More specifically, the 2020 wave captured the beginning of the COVID-19 pandemic which was officially confirmed on the 18 March 2020 in Chile. This is because the data were collected between the beginning of May and the beginning of October of 2020. There are 9127 usable interviews in 2019, 9208 in 2020, and 9423 in 2021.[4]

4.2. Dependent and independent variables

Our starting point is the variable which is probably the most widely used measure in empirical studies of entrepreneurship (Davidsson, 2016): *nascent entrepreneurship*. This is a dummy variable based on the GEM criteria of involvement in entrepreneurial activity. It captures individuals who are involved in launching a new firm and whose new ventures have not yet paid out more than three months of profit and wages. Therefore, in the timeline that leads up to a fully operational new business, nascent entrepreneurship is a step forward from having subjective entrepreneurial intentions; as such, it represents the transitional stage or entry into entrepreneurship (Reynolds et al., 2005). The nascent activity measure has an advantage over the use of new business data in that it is much less subject to problems of reverse causality. This is pertinent to our study because individuals` income is one of the dimensions of our primary interest.[5]

Our dependent variable draws on the nascent entrepreneurship concept but it is split into five categories, reflecting our four-way typology. The baseline category is no involvement in nascent entrepreneurial activity. Then, the registered (formal) and unregistered (informal) nascent businesses are split into necessity and opportunity entry groups, producing the four categories of entrepreneurial entry. Table 1 (which presents the definitions of variables and descriptive statistics) shows that the two basic contrasts, between formal-informal and necessity-opportunity, are not overlapping (Gibbs et al., 2014). This empirical evidence supports the view that it is appropriate to separate the necessity-opportunity and informal-formal entry categorisations.

The main explanatory variable is the income of the head of household. In the Chile survey, this variable is categorised into three intervals of income distribution (low, medium, and higher). We follow the theoretical tradition established by Cassar (2006) and interpret income as the key indicator of the opportunity cost of entrepreneurship.

As control variables, we include all the micro-level variables used in the literature's standard models of nascent entrepreneurship (Parker, 2018b). These comprise the basic demographic variables and labour market characteristics of the respondents. Thus, we include the respondent's age (categorised into seven intervals), gender, number of household members besides the respondent, respondent's work status (seven categories), and their highest educational attainment (seven categories). We further include two variables that describe immigration status: if the respondent was born abroad, and if the respondent has foreign parents. These variables may be associated with social disadvantage (Fairlie and Lofstrom, 2015). These municipality-level variables are lagged by construction (because of the timing of the Census[6]) making our design similar to Capelleras et al. (2019).

We also have standard variables that describe entrepreneurial attitudes and previous experience with entrepreneurship. Here, we include a dummy describing if an individual discontinued a business over the last year, if they are an owner-manager of another registered business, and/or if they are an owner-manager of another unregistered business. These three variables allow us to capture the phenomenon of serial entrepreneurship (Wright et al., 1997), including transitions between unregistered and registered status. We also control for recent involvement in angel investor activities, differentiating between the amounts of investment. Next, we control for network effects by utilising the variable that describes if the respondent knows another person involved in an entrepreneurial project. Finally, we include four variables in which the respondent assesses their entrepreneurial skills, loss aversion, perceptions of business opportunities in the near future, and perceptions of ease of startup regulations (Parker, 2018b).

We also draw on the locational information in GEM to control for spatial aspects. Chile's traditional class divisions, which are largely expressed in terms of low, medium, and higher household incomes, are also correlated with local ethnic divisions (OECD, 2022). Most Chileans belonging to the upper and middle classes have European roots, while most Chileans belonging to the lower

[3] GDP growth in Chile was 0.7 % in 2019, −6.1 % in 2020, and 11.7 % in 2021 (source: World Bank).

[4] However, the actual number of observations used in regressions may sometimes be lower due to the variables of interest being, to a degree, missing.

[5] There may be some reverse causality because while many nascent entrepreneurs keep their options open by holding onto an earlier job, some may quit to concentrate on setting up a new business. Yet, some features of the data alleviate this problem, even if they do not eliminate it. First, the data measures head of household income, which is a good indicator of overall family income but not necessarily the entrepreneur's. This is consistent with conceptualisations of entrepreneurship as the decision of a family/household rather than of an individual (see Sutter et al., 2017). Second, the income data are categorised into three broad categories; thus, only radical shifts will imply moves between the categories. Third, the survey question does not specify the exact time for income, and it is likely that the respondent considers their 'normal' income, averaged over a longer period. Nevertheless, we declare the potential endogeneity issue as a limitation (we are grateful for our anonymous reviewers for a discussion, upon which we draw here).

[6] Further information is available at http://resultados.censo2017.cl/

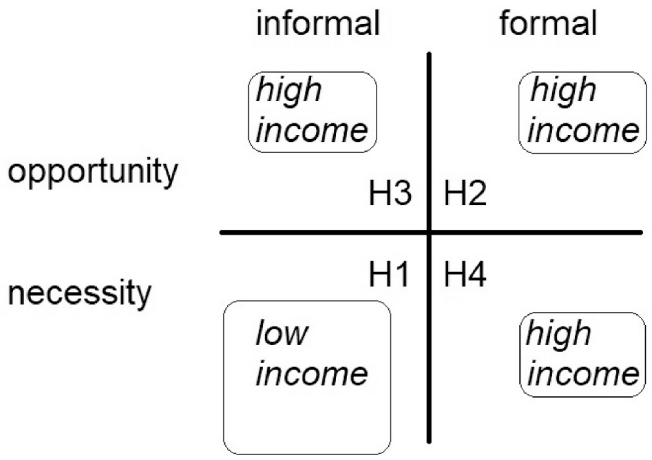

Fig. 1. Proposed Framework for types of entrepreneurial entry.

classes have mestizo and indigenous backgrounds (especially, Mapuche).[7] At the city level, using data from Chile's 2017 Census, we include the municipality share of the indigenous population. This provides a control for social disadvantage and helps to isolate the effect of individuals' income. We also add population density. Finally, the model includes regional dummies and year dummies, and we cluster standard errors on regions.

By including a large set of explanatory variables, we follow the argument of Lindner et al. (2020) and prioritise the minimisation of omission bias over multicollinearity concerns. Saying that, we also run a model where we keep only income dummies and remove all controls. The pattern on income remains the same (with higher significance levels), yet the goodness of fit of this stripped-down model is lower (the AIC criterion increases from 25,503 to 37,883).

As can be seen from the descriptive statistics presented in Table 1, the informal-necessity type of entry is the most common, suggesting a significant overlap between these two aspects. However, this overlap is not complete in that alongside the formal-opportunity type, the two other entry categories are also represented.

4.3. Model and estimation methods

To evaluate our hypotheses, we obtain estimates for the combined 2019, 2020, and 2021 samples. We use multinomial logit estimator with five categories. Our estimated equations for probabilities of entrepreneurial entry alternatives are as follows (Wooldridge, 2010):

$$prob(yi, t = j \mid \boldsymbol{X}) = exp(\boldsymbol{XI}, t\boldsymbol{\beta j} + \boldsymbol{R\gamma j} + \boldsymbol{T\eta j}) \Big/ \left[1 + \sum_{h=1}^{J} exp\left(\boldsymbol{X}_{i,t}\boldsymbol{\beta}_{\boldsymbol{h}} + \boldsymbol{X}_{i,t} + \boldsymbol{R\gamma}_{\boldsymbol{h}} + \boldsymbol{T\eta}_{\boldsymbol{h}}\right)\right] \quad (1)$$

where y indicates an alternative type of engagement in entrepreneurial activity, j ranges from 1 to 4 and denotes one of four types of entrepreneurial entry (with the baseline outcome of not engaging with entrepreneurship being denoted as 0), subscript i refers to observations, t relates to three time periods (2019, 2020, 2021), $\boldsymbol{X\beta}$ is the matrix of explanatory variables and their coefficients, $\boldsymbol{R\gamma}$ denotes the set of regional dummies, and $\boldsymbol{T\eta}$ represents year dummies.

We follow another best practice recommendation and focus on average marginal effects instead of coefficients or odds ratios from logit estimators because these are affected by omitted variables even when they are unrelated to the independent variables in the model. This shortcoming results from the construction of the logit estimator, particularly its fixed variance (Mood, 2010).

The multinomial logit model relies on the assumption of the irrelevance of independent alternatives (IIA). We perform four post-estimation Hausman specification tests in which we compare the coefficients obtained from the model with versions of the same but where each of the four entrepreneurial entry options is removed in turn. χ^2 obtained from these models is −13.59, 0.87, 9.22, and 23.35, respectively, implying that the IIA assumption cannot be rejected at standard significance thresholds.

Another important specification consideration is whether any alternatives included as the outcomes of the multinomial logit model can be combined. The corresponding post-estimations Wald test for all possible pairs of alternatives produces high χ^2 ranging from 111 to 2138, thus consistently rejecting combining the alternatives at a probability level below 0.001. This provides preliminary support for our theoretical strategy of separating the four entrepreneurial entry paths.

Finally, for raw measures of association, Pearson's correlation coefficients (for pairs of continuous variables), Pearson's χ^2 based on contingency tables (for categorical variables) and point bi-sectoral correlations (for pairs of continuous and dichotomous variables

[7] The ethnic heterogeneity was amplified by recent migratory movements (in particular, Chile has become host to 457,000 Venezuelan refugees since 2016).

Table 1
Variable definitions and descriptive statistics.

Variable label	Description	Mean	Std.Dev.
Dependent variable categories (baseline: no involvement in nascent entrepreneurs)			
Formal opportunity nascent entr.	& Opportunity start-up involvement	0.02	0.40
Informal opportunity nascent entr.	& Opportunity start-up involvement	0.04	0.19
Formal necessity nascent entr.	& Necessity start-up involvement	0.04	0.20
Informal necessity nascent entr.	& Necessity start-up involvement	0.11	0.31
Hypotheses related explanatory variables (head of household income):			
Low-income	Lowest 33 % percentile	0.30	0.46
Middle-income	Middle 33 % percentile	0.44	0.50
High-income	Highest 33 % percentile	0.26	0.44
Control variables:			
Age	Age of respondent (categorised)		
	18–24	0.12	0.33
	25–34	0.23	0.42
	35–44	0.20	0.40
	45–54	0.21	0.40
	55–64	0.14	0.35
	65–99	0.10	0.30
Female	Female respondent	0.53	0.50
No of members of household	No of members of household	3.45	1.58
Work Status	Work status		
	Full-time employee	0.43	0.50
	Part-time employee	0.06	0.23
	Retired, disabled	0.06	0.24
	Homemaker	0.05	0.22
	Student	0.03	0.18
	Not working	0.08	0.29
	Self-employed	0.27	0.45
Education	Highest level of educational attainment		
	Primary education or first stage of basic educ.	0.05	0.21
	Lower secondary or second stage of basic	0.06	0.24
	(Upper) secondary education	0.29	0.45
	Post-secondary non-tertiary education	0.21	0.41
	Short-cycle tertiary education	0.09	0.28
	Bachelor or equivalent	0.24	0.43
	Master or equivalent	0.07	0.25
Born abroad	Born abroad	0.05	0.22
Foreign parents	Foreign parents	0.07	0.25
Discontinued	Discontinued business in last 12 months	0.07	0.26
Knows entrepreneurs	Knows somebody who started a business	0.68	0.47
Opportunities	Sees opportunities for start-up next six months	0.46	0.50
Entrepreneurial skills	Declares start-up knowledge, skills, experience	0.66	0.47
Inf. investor	Informal investor within last three years, categorised by the size of investment		
	not an informal investor	0.78	0.41
	invested less than $1 k	0.07	0.26
	invested more than $1 k and less than $3 k	0.07	0.25
	invested $3 k or more	0.08	0.27
Fear of failure	Would not start a business for fear it might fail	0.53	0.50
Easy to start a business	In your country, it is easy to start a business	0.44	0.50
Owner-manager of registered	Owner-manager of operational (young or established) registered business	0.11	0.31
Owner-manager of unregistered	Owner-manager of operational (young or established) unregistered business	0.03	0.18
Density	Population density	1.046	3.132
Indigenous	Share of indigenous population	0.17	0.11

derived from categorical variables) are available on request.

5. Results

We run a multinomial logit model corresponding to specification (1). The results are presented in Table 2, in which we present average marginal effects for each type of entrepreneurial entry.

5.1. Results related to the hypotheses

Fig. 2 shows all average marginal effects related to income to facilitate the interpretations. Our general observation is that the marginal effects are estimated precisely, as illustrated by the narrow confidence intervals. This is despite the fact that we have combined three years (2019–2021) that represent very different economic situations: low growth economy, the COVID-19 crisis, and the beginning of the recovery from COVID-19. Entrepreneurial activity altered considerably over these three years but the different

types of entrepreneurial entry move in a predominantly parallel way; hence, the relative effects with which we are concerned are clearly identified across the whole period.

5.1.1. Informal-necessity entrepreneurial entry (Type 1)

All income groups exhibit the greatest propensity to entrepreneurial entry along the informal-necessity path, as illustrated by the lower left panel of Fig. 2. This is consistent with the standard view of the informal sector, as discussed. However, this propensity decreases with income (i.e., the slope of the line connecting the average marginal effects is negative). It is the lowest-income group for which this type of entry is relatively most common, which is consistent with Hypothesis 1.

5.1.2. Formal-opportunity entrepreneurial entry (Type 2)

A more surprising result is the lowness of the propensity to enter along the formal-opportunity path (upper right panel). The slope is positive indicating that it is the highest-income group for which this type of entry is the most characteristic, consistent with Hypothesis 2. However, even in this group, it remains the least popular alternative out of the four we consider.

5.1.3. Informal-opportunity entrepreneurial entry (Type 3)

The propensity to enter along the informal-opportunity route is higher for all income groups (upper left panel) compared with the formal-opportunity route (upper right panel). The positive slope of the line is consistent with Hypothesis 3. The pattern therefore supports the argument that the informal sector acts as a testing ground.

5.1.4. Formal-necessity entrepreneurial entry (Type 4)

The formal-necessity route is also quite common. We find it to be more characteristic for middle- and high-income groups than for the low-income group (lower right panel). This is consistent with Hypothesis 4.

5.2. Results related to control variables

We also consider the results on individual characteristics other than income, namely age, gender, education, work status, networking effects, and entrepreneurial skills.

For age, the marginal effects for both types of informal entry are negative and significant for the middle age group. The highest positive age-related average marginal effects are for respondents aged 35–54 for formal-necessity entry (Type 4). Informal-necessity entry (Type 1) is most characteristic for women, indicating their disadvantaged position. For education, the largest (positive) average marginal effects relate to informal-opportunity entry (Type 3) for those with higher educational attainment. For this entry type, the size of these effects increases monotonically as we move up the educational ladder (column 3 of Table 2). For work status, the most striking finding relates to those who are self-employed. While their propensity to engage in all categories of entrepreneurship is higher than for full-time employees (the baseline category), the marginal effect is largest for informal-necessity entry (Type 1). When entrepreneurs are pushed into a new entrepreneurial project, they have the competence to do it, hence the high average marginal effect in this category. This may be compared with the retired and disabled category, for whom we see a large negative average marginal effect for informal-necessity entry (Type 1), as well as for students. For networking ("knows someone who started a business"), the Table 2 results suggest that it enhances the propensity to all types of entry. However, like individuals with self-employment experience, the strongest positive average marginal effect is on informal-necessity entry (Type 1). For entrepreneurial skills, we see a positive effect for formal-opportunity entry (Type 2), which is also the strongest one. However, this time the second strongest is for informal-opportunity entry (Type 3). Taken together, the results imply that specific human capital and its equivalent accessed through social channels work in similar ways.

5.3. Robustness tests and extensions

We first explore whether our results are consistent across different years. The effects on individual income groups reported above are precisely estimated when the data are pooled, and this suggests that propensities to engage in entrepreneurship entry paths may move together across the growth period (2019), the COVID crisis (2020), and the beginning of recovery period (2021). Fig. 3 illustrates this with simple sample averages split by years. Apart from one case, the ordering of all choices for all individual income groups is preserved between the (weak) growth economy (2019 sample), the COVID-19 crisis (2020 sample), and the post-COVID-19 recovery (2021 sample). Thus, the pandemic does not change the basic logic of relative effects illustrated in Fig. 2. However, there is one exception: the crisis has the greatest impact on the propensity of the high-income group to engage in informal-opportunity type of entry. This is represented by the green line on the lower panel, for which the negative slope between 2019 and 2020 is the steepest. Yet it recovers relatively quickly in 2021 so the informal-opportunity entry (Type 3) exhibits a more pronounced V-shape than the other categories.

To gain further insights into these patterns, we run models like those reported in Table 2 but restrict them to the comparison between the (weak) growth economy period (2019) and the deep crisis period (2020). Here, we add interactions of all variables with

Table 2
Entrepreneurship (nascent start-up involvement): Average marginal effects of multinomial logit model.

	(1) Informal-necessity	(2) Formal-necessity	(3) Informal-opportunity	(4) Formal-opportunity
Hypotheses related variables				
Baseline: Low-income				
Middle-income	−0.0132*	0.0128**	0.0120**	0.00730*
	(0.00545)	(0.00396)	(0.00422)	(0.00317)
High-income	−0.0452***	0.0110*	0.0282***	0.0161***
	(0.00789)	(0.00506)	(0.00493)	(0.00351)
Control variables				
Baseline: Age 18–24				
25–34	−0.00717	0.0280***	−0.00327	0.00465
	(0.00776)	(0.00693)	(0.00461)	(0.00390)
35–44	−0.0179*	0.0336***	−0.0116*	0.00800*
	(0.00817)	(0.00699)	(0.00493)	(0.00400)
45–54	−0.0305***	0.0369***	−0.021***	0.00396
	(0.00830)	(0.00697)	(0.00538)	(0.00412)
55–64	−0.0502***	0.0273***	−0.031***	0.00514
	(0.00966)	(0.00754)	(0.00647)	(0.00439)
65–99	−0.100***	0.00605	−0.048***	0.00111
	(0.0141)	(0.00956)	(0.0104)	(0.00540)
Female	0.0197***	−0.0194***	−0.00410	−0.00731***
	(0.00447)	(0.00300)	(0.00271)	(0.00189)
No of members of household	0.00135	0.000269	−0.00183*	0.000340
	(0.00139)	(0.000908)	(0.00093)	(0.000581)
Baseline: full time employee				
Part time only	−0.0161	−0.0120	−0.00931	−0.00375
	(0.0105)	(0.00951)	(0.00647)	(0.00573)
Retired or disabled	−0.0741***	−0.0424+	−0.0314+	−0.0162
	(0.0219)	(0.0230)	(0.0179)	(0.0145)
Homemaker	−0.0188	0.00267	−0.0332*	−0.00366
	(0.0128)	(0.0111)	(0.0130)	(0.00851)
Student	−0.0930***	−0.0436	−0.0237*	0.00268
	(0.0218)	(0.0277)	(0.0113)	(0.00910)
Not working	−0.0177+	0.0000943	−0.032***	−0.0332*
	(0.00949)	(0.00796)	(0.00826)	(0.0147)
Self-employed	0.116***	0.0674***	0.0144***	0.0201***
	(0.00509)	(0.00355)	(0.00324)	(0.00201)
Baseline: Primary educ. or 1st stage basic				
Lower 2ry or 2nd stage of basic educ.	0.0163	0.0197*	0.00945	−0.00585
	(0.0139)	(0.00958)	(0.0160)	(0.00792)
(Upper) secondary education	0.0242*	0.0148+	0.0305*	−0.00370
	(0.0117)	(0.00835)	(0.0133)	(0.00622)
Post-secondary non-tertiary education	0.0276*	0.0216*	0.0369**	0.00649
	(0.0121)	(0.00848)	(0.0134)	(0.00613)
Short-cycle tertiary education	0.0157	0.0230*	0.0422**	0.00827
	(0.0138)	(0.00973)	(0.0139)	(0.00661)
Bachelor or equivalent	0.00760	0.0295***	0.0388**	0.00970
	(0.0128)	(0.00867)	(0.0136)	(0.00615)
Master or equivalent	−0.0219	0.0345***	0.0431**	0.0115+
	(0.0164)	(0.00970)	(0.0141)	(0.00658)
Born abroad	0.0156	−0.00388	0.00297	−0.000558
	(0.0134)	(0.00844)	(0.00727)	(0.00563)
Foreign parents	0.00240	0.0113	0.00887	−0.00408
	(0.0121)	(0.00697)	(0.00647)	(0.00481)
Discontinued business in last 12 months	0.0263***	0.0136**	0.00690	0.00435
	(0.00742)	(0.00448)	(0.00472)	(0.00284)
Knows somebody who started a business	0.0366***	0.0179***	0.0193***	0.00693**
	(0.00535)	(0.00372)	(0.00364)	(0.00246)
Opportunities for startup next 6 months	0.0108*	0.00172	0.0108***	0.000526
	(0.00454)	(0.00295)	(0.00278)	(0.00182)
Startup knowledge skills experience	0.0932***	0.0342***	0.0181***	0.0133***
	(0.00611)	(0.00450)	(0.00348)	(0.00294)
Baseline: Not informal investor in last 3 yrs				
Informal investor in last 3 yrs.: <$1 k	0.00752	−0.0145*	−0.00212	−0.00368
	(0.00781)	(0.00622)	(0.00481)	(0.00390)
Informal Investor in last 3 yrs.: $1 k–3 k	−0.00665	−0.00433	−0.00164	0.00200
	(0.00875)	(0.00543)	(0.00471)	(0.00281)
Informal Investor in last 3 yrs.: >$3 k	0.00131	0.00244	−0.00387	0.00157
	(0.00861)	(0.00461)	(0.00456)	(0.00263)

(*continued on next page*)

Table 2 (*continued*)

	(1) Informal-necessity	(2) Formal-necessity	(3) Informal-opportunity	(4) Formal-opportunity
Wouldn't start business for fear it might fail	−0.0168***	−0.0102***	−0.015***	−0.00956***
	(0.00432)	(0.00281)	(0.00264)	(0.00181)
It is easy to start a business	−0.00844+	0.00167	0.00214	0.00300+
	(0.00453)	(0.00294)	(0.00276)	(0.00182)
Registered business	−0.173***	−0.0529***	−0.024***	−0.0147***
	(0.0119)	(0.00571)	(0.00586)	(0.00313)
Unregistered business	−0.142***	−0.0628***	−0.0264+	−0.0321*
	(0.0219)	(0.0153)	(0.0146)	(0.0145)
Share of indigenous population	0.0981**	0.0229	−0.0457+	0.00782
	(0.0333)	(0.0257)	(0.0242)	(0.0143)
Population density	0.00132	0.000413	−0.000242	0.000330
	(0.00112)	(0.000694)	(0.00057)	(0.000365)
Baseline: Year survey administered = 2019				
Year survey was administered = 2020	−0.00749	−0.0180***	−0.030***	−0.00930***
	(0.00547)	(0.00351)	(0.00340)	(0.00220)
Year survey was administered = 2021	−0.0218***	−0.0124***	−0.026***	−0.00652**
	(0.00565)	(0.00346)	(0.00326)	(0.00208)

Notes: Akaike Information Criterion: 25503,097. Standard errors in parentheses; + $p < 0.10$ * $p < 0.05$ ** $p < 0.01$ *** $p < 0001$. Average marginal effects for regional dummies are not reported to save space.

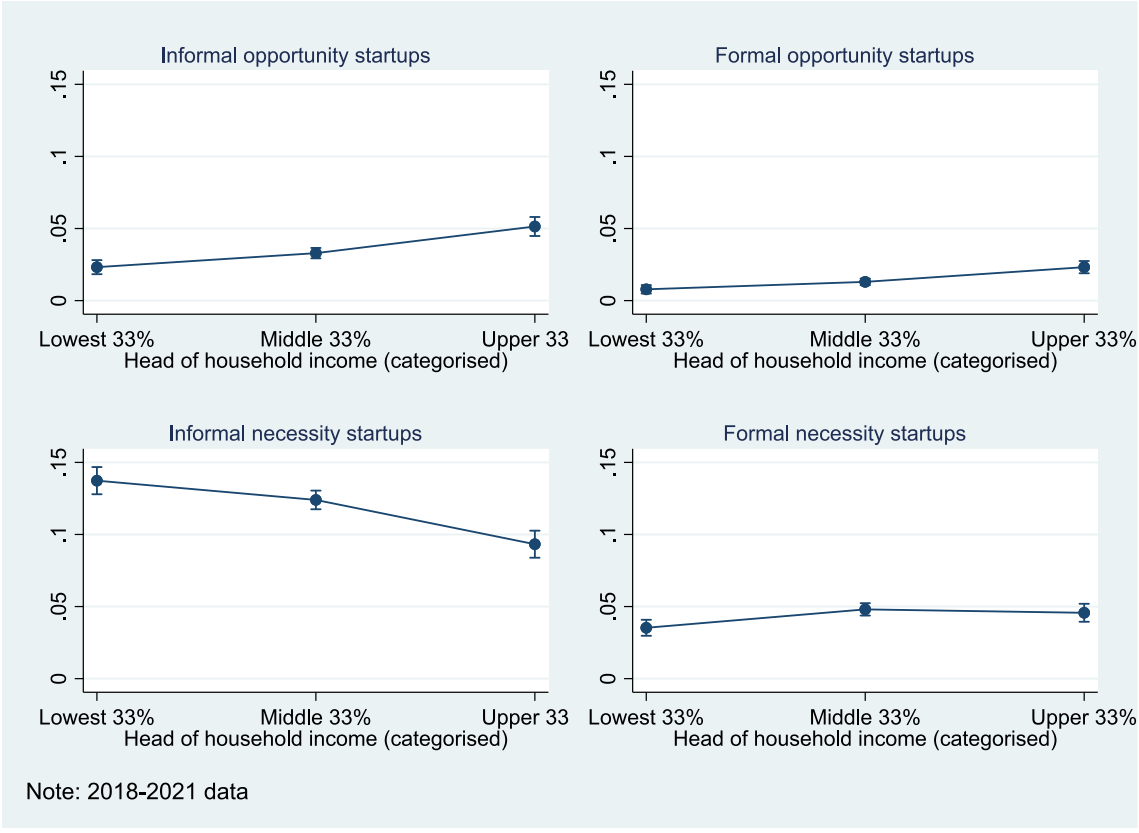

Fig. 2. Average marginal effects of income on categories of nascent entrepreneurship (from Table 2).

the 2020 dummy to tease out the effects that may be characteristic of either the pre-crisis or the crisis periods and calculate the average marginal effects. The results, as presented in Tables 3 and 4, are now more complex as we have doubled the number of effects. To facilitate interpretation, we have illustrated the key effects in Figs. 4 and 5.[8]

[8] We also run an analogous comparison between 2019 and 2021, in which the latter year represents the beginning of recovery (available on request).

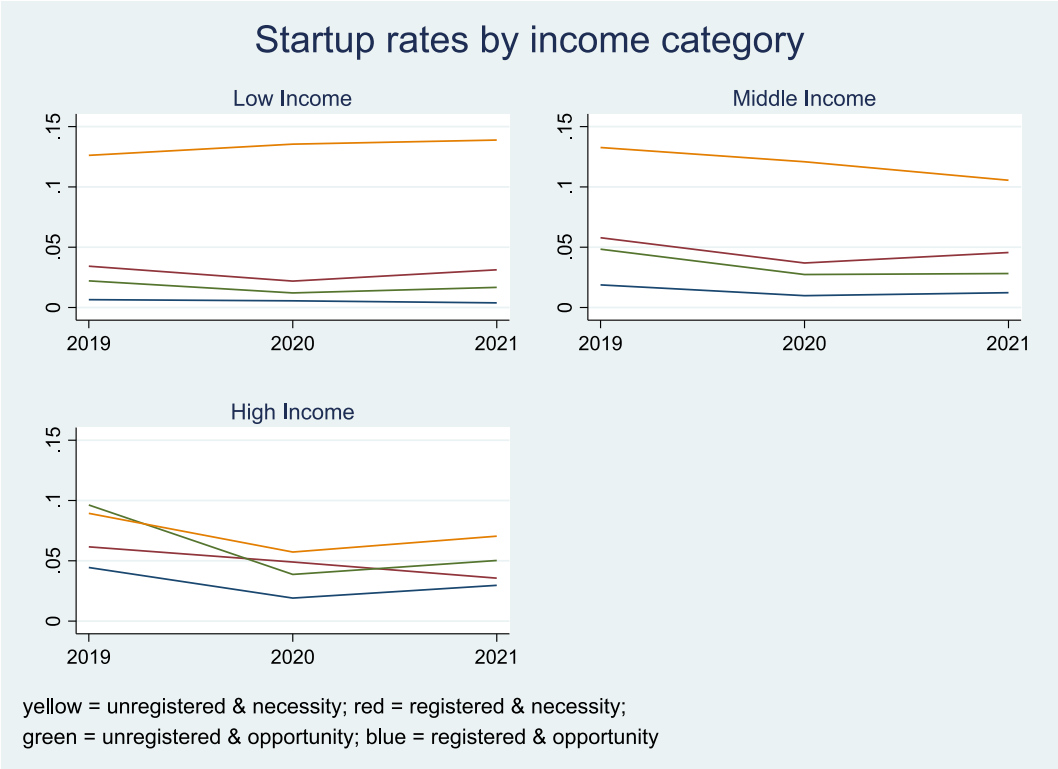

Fig. 3. Sample means of categories of nascent entrepreneurship by individuals'income and survey years.

Thus, our focus is now on the differences in income group effects between the pre-crisis and crisis periods. The baseline remains non-involvement in an entrepreneurial activity, alongside which the four entrepreneurial entry choices run: informal-necessity (Type 1), formal-opportunity (Type 2), informal-opportunity (Type 3), and formal-necessity (Type 4). However, all variables are now interacted with the 2020 dummy, and we focus on average marginal effects, which are presented in Tables 4 and 5 below. Related to necessity entry (Table 3), we can see that the contrast between the higher- and the lower-income individuals changes in a different way for informal compared with formal entry. During the crisis, informal-necessity entry (Type 1) becomes less likely for higher-income individuals compared with lower-income individuals, whereas formal-necessity entry (Type 4) becomes more likely for the economically better-off than for the lower-income group. Fig. 4 illustrates the finding by plotting the marginal effects of formal- and informal necessity entry (Type 4 and Type 1, respectively). We can observe that in the upper right-hand panel of Fig. 4, the confidence intervals between the higher-income individuals and the lower-income individuals overlap. However, in the lower right-hand panel, they do not. Thus, in the case of formal entry, there are slightly larger differences between the higher-income individuals and the lower-income individuals at a time of crisis.

Now, we turn to results on opportunity entry, which are reported in Table 4. The most pronounced difference between the higher-income individuals and the lower-income individuals relate to informal-opportunity entry (Type 3) during the good times, as documented by the size of the corresponding marginal effects in Column 1 of Table 4, and likewise by the upper left-hand panel of Fig. 5. The difference remains during the crisis, but it shrinks by more than half (Column 2 of Table 4; lower left-hand side panel of Fig. 5), consistent with the pattern in Fig. 3.

6. Discussion and conclusions

6.1. Hypotheses testing and academic contributions

Our research questions considered whether the entry of individuals into entrepreneurship can be meaningfully separated into four categories, derived by overlaying the informal-formal modes of entry on the necessity-opportunity motivations for entry, and how these four entry choices are influenced by people's opportunity costs as indicated by their incomes. Our hypotheses concerned how the patterns of entrepreneurial entry, categorised jointly by formal versus informal and necessity versus opportunity, are associated with individuals' income groups.

We now develop the contributions already noted in the introduction. Our first contribution is our utilisation of a four-way categorisation of entrepreneurial entry as informal-necessity, formal-opportunity, informal-opportunity, and formal-necessity (Gibbs et al., 2014; Dencker et al., 2021; Salvi et al., 2022). We thus extend the discussion about the typology of entrepreneurial entry. To this, we

Table 3
Cross-section of formal-informal entry and necessity-opportunity, 2019 and 2020, part 1.

	(1) Informal, necessity '19	(2) Informal, necessity '20	(3) Formal, necessity '19	(4) Formal, necessity '20
Explanatory variable:				
Middle-Income	0.0000311	−0.0163+	0.0117	0.0158**
	(0.0110)	(0.00862)	(0.00787)	(0.00602)
High-income	−0.0213	−0.0729***	0.0205*	0.0233**
	(0.0155)	(0.0135)	(0.00983)	(0.00794)
Control variables:				
Age 25–34	0.00632	−0.0244+	0.0442**	0.0148
	(0.0167)	(0.0137)	(0.0169)	(0.0102)
Age 35–44	−0.000195	−0.0335*	0.0643***	0.0153
	(0.0173)	(0.0144)	(0.0167)	(0.0104)
Age 45–54	−0.0166	−0.0390**	0.0620***	0.0199+
	(0.0176)	(0.0145)	(0.0168)	(0.0103)
Age 55–64	−0.0145	−0.0644***	0.0557**	0.00939
	(0.0188)	(0.0167)	(0.0175)	(0.0111)
Age 65–99	−0.0970***	−0.0923***	0.0277	−0.00450
	(0.0277)	(0.0224)	(0.0204)	(0.0148)
Female	0.0126	0.0132+	−0.0118*	−0.0199***
	(0.00893)	(0.00720)	(0.00587)	(0.00473)
No of members of household	0.00153	0.00222	0.000920	−0.000153
	(0.00261)	(0.00223)	(0.00170)	(0.00140)
Part time only	−0.0347+	0.0118	−0.00368	0.00389
	(0.0210)	(0.0159)	(0.0179)	(0.0127)
Retired or disabled	0.0660	−0.0447	−0.640***	0.00692
	(0.0410)	(0.0311)	(0.0367)	(0.0238)
Homemaker	−0.0137	0.00867	−0.0207	0.0264*
	(0.0289)	(0.0163)	(0.0323)	(0.0117)
Student	−0.0780+	0.0288	−0.00579	−0.454***
	(0.0406)	(0.0381)	(0.0467)	(0.0289)
Not working	0.0150	0.00287	0.0244	0.0174*
	(0.0206)	(0.0128)	(0.0214)	(0.00885)
Self-employed	0.0808***	0.136***	0.0899***	0.0629***
	(0.0106)	(0.00860)	(0.00726)	(0.00602)
Lower sec. or sec. Stage of basic ed.	0.0166	0.0104	0.0156	0.0172
	(0.0240)	(0.0228)	(0.0153)	(0.0169)
(Upper) secondary education	0.0173	0.0300	0.00298	0.0210
	(0.0201)	(0.0196)	(0.0130)	(0.0145)
Post-secondary non-tertiary education	−0.00816	0.0510*	0.0162	0.0227
	(0.0214)	(0.0202)	(0.0137)	(0.0147)
Short-cycle tertiary education	0.0103	0.0320	0.00913	0.0321*
	(0.0264)	(0.0226)	(0.0177)	(0.0160)
Bachelor or equivalent	−0.0117	0.0360+	0.0188	0.0306*
	(0.0225)	(0.0212)	(0.0140)	(0.0151)
Master or equivalent	−0.0259	−0.000773	0.0219	0.0448**
	(0.0292)	(0.0270)	(0.0165)	(0.0159)
Born abroad	0.0447	−0.0126	0.0239+	−0.0292*
	(0.0284)	(0.0214)	(0.0138)	(0.0137)
Foreign parents	−0.0356	0.0348+	−0.00153	0.0259*
	(0.0263)	(0.0191)	(0.0119)	(0.0103)
Discontinued business in last 12 months	0.00968	0.0300*	0.0149	0.0196**
	(0.0154)	(0.0121)	(0.00958)	(0.00631)
Knows somebody who started a bus.	0.0176+	0.0528***	0.0235**	0.0165**
	(0.00997)	(0.00898)	(0.00737)	(0.00591)
Opportunities for start-up next 6 months	0.00384	0.0173*	−0.00411	−0.00199
	(0.00932)	(0.00717)	(0.00610)	(0.00451)
Start-up knowledge skills experience	0.0822***	0.112***	0.0351***	0.0437***
	(0.0112)	(0.0111)	(0.00816)	(0.00898)
Informal investor in last 3 yrs.: <$1 k	0.0142	−0.0124	−0.0183	−0.00599
	(0.0158)	(0.0134)	(0.0130)	(0.00851)
Informal Investor in last 3 yrs.: $1 k–3 k	−0.00843	−0.0166	−0.00641	−0.00827
	(0.0182)	(0.0147)	(0.0114)	(0.00904)
Informal Investor in last 3 yrs.: >$3 k	−0.0316+	0.0264*	−0.00288	0.00929
	(0.0188)	(0.0129)	(0.00995)	(0.00645)
Wouldn't start bus. For fear it might fail	0.00647	−0.0208**	−0.0108+	−0.00441
	(0.00875)	(0.00690)	(0.00565)	(0.00425)
It is easy to start a business: yes	−0.0133	−0.00716	0.00132	0.00474
	(0.00964)	(0.00723)	(0.00606)	(0.00436)
Registered business	−0.144***	−0.212***	−0.0694***	−0.0398***
	(0.0191)	(0.0229)	(0.00999)	(0.00870)

(*continued on next page*)

Table 3 (*continued*)

	(1) Informal, necessity '19	(2) Informal, necessity '20	(3) Formal, necessity '19	(4) Formal, necessity '20
Unregistered business	−0.0445	−0.174***	−0.0352	−0.0555*
	(0.0315)	(0.0387)	(0.0237)	(0.0254)
Share of indigenous population	0.0819	0.0918*	0.0467	−0.0243
	(0.0544)	(0.0458)	(0.0427)	(0.0297)
Population density	0.00000140	−0.00000117	0.000000287	0.000000446
	(0.000001)	(0.0000017)	(0.00000104)	(0.000000969)
Year survey was administered = 2020	−0.0186*	−0.0000978	−0.0261***	−0.00802*
	(0.00755)	(0.00533)	(0.00637)	(0.00394)
Observations	12,708	12,708	12,708	12,708

Notes: Standard errors in parentheses; + p < 0.10 * p < 0.05 ** p < 0.01 *** $p < 0.001$. Regional dummies included but not reported.

apply the dynamic conceptualisation of occupational choice (Blau et al., 1956; Nagler, 2015), interpreting it as a process through which economic actors learn and update their choices. We explain that higher-income individuals may choose informal entry because its setup costs are lower than those of formal entry, making it a useful context in which to explore the value of a risky opportunity. Conditional on their learning about the value of the opportunity, they may either formalise their venture to maximise its scaling up opportunities or they may, given that opportunity exploration implies a possibility of reversing the entry decision, discontinue the venture. Thus, informal entry is used as a proving ground or seedbed for new entrepreneurial ventures, especially where there is greater uncertainty about future success. Examples of informal entry as a seedbed for business ideas are reported by De Soto (1989) and Maloney (2004).

In contrast, the choice of necessity entrepreneurship indicates a lack of attractive options in paid employment, which may imply a greater commitment to stay the course of entrepreneurial entry. Under these conditions, formalisation will be more likely if necessity entrepreneurship occurs in sectors where, for example, sub-contracting to the public sector or international firms is common, such as in some areas of maintenance and business-to-business services. Necessity entrepreneurs will prefer to avoid the costs of registration when the benefits of formality are minimal, for example, in street trading or consumer services. Hence, we suggest that necessity entrepreneurship may be associated with accepting the costs of formal entry. At the same time, low-income individuals will be less likely to use the strategy of informal entry as an exploration of opportunity because they typically lack access to the resources that would enable them to undertake such experimentation, and they will be more wary of entry that entails high risks. This links with the interpretation of occupational choice theory that emphasises the critical importance of financial constraints and imperfect access to credit, especially in emerging market economies (Banerjee and Newman, 1993). Our analysis implies that neither informal entry nor necessity motivation are restricted to lower-income individuals. When the analysis takes account of the income of potential entrepreneurs, one can identify not only the formal-opportunity and informal-necessity entry modes stressed in the existing literature, but also motivations for both formal-necessity entry and informal-opportunity entry.

These arguments are strengthened by our comparison of the four types of entrepreneurial entry during a normal versus crisis period. While the comparison was undertaken as a robustness check, it also illustrates the case of an exogenous change in income and therefore allows us to refine and sharpen our discussion. We had wished to verify that the interplay between individuals´income groups and the four entrepreneurial entry modes remains stable over normal times versus crisis. But through this extension of our core results, we were able to identify more sharply how the benefits and opportunity costs of entrepreneurial entry might change when an individual's income alters during a crisis. We argue that because the crisis did not much alter the relevant costs and benefits of entry for lower-income individuals, their entrepreneurial activity would not be greatly altered. A more distinctive aspect concerns the impact of the crisis on higher-income individuals. We propose that they would continue to be likely to enter formally in a crisis, but mostly more for necessity motives (Type 4). At the same time, the seedbed model of entry would become less attractive during the crisis because of shrinkage in the entrepreneurial opportunity set, making the informal-opportunity entry (Type 3) less likely for higher-income individuals. This in fact proved to be the most pronounced effect during the crisis, and in that regard, our study contributes to the academic debate about how shakeouts might change entrepreneurs' participation in the formal and informal sectors (Dencker et al., 2021).

Our next contribution, which can be seen as an aspect of the first, is empirical. Uniquely, based on Chilean GEM data that include a distinction between the formal and informal sectors, we are able to use individuals' incomes to disentangle empirically the factors driving the four entrepreneurial entry modes. Thus, we propose a method of operationalising the four-way typology that may be applied by other researchers. This operationalisation helps to identify additional empirical evidence for informal entrepreneurship as more than just a way for lower-income individuals to support themselves economically in a situation of necessity within an emerging economy. The empirical results support the view that higher-income individuals also use informal entry but as a way of exploring their opportunity-based business ideas. This allows us to progress empirical research on entrepreneurship in emerging economies (Estrin et al., 2019).

6.2. Limitations and future research

There are a few other avenues for further research that we did not explore due to space limitations but which might be taken up by future researchers. Williams and Vorley (2015) emphasise that crisis can produce changes in government intervention, and that some fiscal measures may outlive the crisis that necessitated their introduction. Thus, a crisis may cause a longer-term policy shift that

Table 4
Cross-section of formal-informal entry and necessity-opportunity, 2019 and 2020, part 2.

	(1) Informal-opportunity 2019	(2) Informal-opportunity 2020	(3) Formal-opportunity 2019	(4) Formal-opportunity 2020
Explanatory variable:				
Middle-income	0.0176+	0.0106*	0.0125+	0.00196
	(0.0103)	(0.00525)	(0.00743)	(0.00355)
High-income	0.0483***	0.0145*	0.0268***	0.00627
	(0.0119)	(0.00634)	(0.00772)	(0.00441)
Control variables:				
Age 25–34	−0.0108	−0.00322	0.000382	0.00458
	(0.0104)	(0.00696)	(0.0106)	(0.00535)
Age 35–44	−0.0186+	−0.00550	0.0154	0.00643
	(0.0111)	(0.00722)	(0.0106)	(0.00544)
Age 45–54	−0.0419***	−0.0139+	0.00960	0.00149
	(0.0124)	(0.00789)	(0.0107)	(0.00599)
Age 55–64	−0.0529***	−0.0173+	0.0123	0.000632
	(0.0144)	(0.00915)	(0.0107)	(0.00645)
Age 65–99	−0.0611**	−0.0333*	0.00823	−0.000604
	(0.0210)	(0.0138)	(0.0119)	(0.00788)
Female	−0.00337	−0.00432	−0.00553	−0.00712**
	(0.00625)	(0.00363)	(0.00384)	(0.00264)
No of members of household	−0.00388+	−0.000586	−0.00111	0.000282
	(0.00227)	(0.00112)	(0.00120)	(0.000835)
Part time only	−0.0293+	−0.00379	−0.00351	0.00288
	(0.0157)	(0.00840)	(0.0111)	(0.00658)
Retired or disabled	−0.0290	−0.00454	0.0276	−0.138***
	(0.0519)	(0.0169)	(0.0190)	(0.0164)
Homemaker	−0.0971+	−0.00864	0.00192	0.00228
	(0.0500)	(0.0107)	(0.0186)	(0.00784)
Student	−0.0329	−0.0152	0.0115	0.0270**
	(0.0250)	(0.0227)	(0.0203)	(0.00950)
Not working	−0.0389+	−0.0209*	−0.265***	−0.0149
	(0.0232)	(0.00940)	(0.0264)	(0.0108)
Self-employed	0.00834	0.0153***	0.0253***	0.0156***
	(0.00808)	(0.00424)	(0.00413)	(0.00318)
Lower sec. or sec. Stage of basic ed.	0.0208	−0.0105	−0.00770	0.00515
	(0.0352)	(0.0187)	(0.0129)	(0.0125)
(Upper) *sec*ondary education	0.0548+	0.00910	−0.0127	0.00756
	(0.0296)	(0.0137)	(0.0110)	(0.0108)
Post-secondary non-tertiary education	0.0647*	0.0105	0.00353	0.0138
	(0.0303)	(0.0139)	(0.0106)	(0.0107)
Short-cycle tertiary education	0.0718*	0.0144	0.00542	0.0136
	(0.0321)	(0.0146)	(0.0127)	(0.0111)
Bachelor or equivalent	0.0711*	0.0138	0.00818	0.0148
	(0.0307)	(0.0141)	(0.0109)	(0.0108)
Master or equivalent	0.0584+	0.0271+	0.00918	0.0143
	(0.0322)	(0.0145)	(0.0117)	(0.0114)
Born abroad = 1	0.00214	−0.00139	−0.0102	0.000749
	(0.0147)	(0.00859)	(0.0127)	(0.00786)
Foreign parents = 1	0.0263*	−0.000682	−0.0141	0.000141
	(0.0129)	(0.00779)	(0.00998)	(0.00697)
Discontinued business in last 12 months = 1	0.00520	0.0117*	0.00350	0.00118
	(0.0113)	(0.00594)	(0.00632)	(0.00397)
Knows somebody who started a business = 1	0.0220**	0.0143**	0.0146**	0.00474
	(0.00789)	(0.00506)	(0.00556)	(0.00342)
Opportunities for start-up next 6 months = 1	0.0106	0.00933**	−0.00300	−0.000221
	(0.00649)	(0.00362)	(0.00392)	(0.00248)
Start-up knowledge skills experience = 1	0.0199**	0.0119*	0.0108*	0.0170**
	(0.00720)	(0.00539)	(0.00513)	(0.00632)
Informal investor in last 3 yrs.: <$1 k	0.00260	−0.00344	−0.00448	−0.000285
	(0.0108)	(0.00638)	(0.00887)	(0.00457)
Informal Investor in last 3 yrs.: $1 k–3 k	0.00519	−0.0137+	0.00260	−0.00144
	(0.0108)	(0.00765)	(0.00588)	(0.00473)
Informal Investor in last 3 yrs.: >$3 k	−0.00839	−0.00746	0.000680	−0.00204
	(0.0107)	(0.00665)	(0.00557)	(0.00405)

(*continued on next page*)

Table 4 (*continued*)

	(1) Informal-opportunity 2019	(2) Informal-opportunity 2020	(3) Formal-opportunity 2019	(4) Formal-opportunity 2020
Wouldn't start business for fear it might fail	−0.00426	−0.0154***	−0.00348	−0.0127***
	(0.00600)	(0.00367)	(0.00363)	(0.00298)
It is easy to start a business: yes	0.00394	0.00712+	0.00425	0.00115
	(0.00673)	(0.00365)	(0.00407)	(0.00251)
Registered business	−0.0216+	−0.0224*	−0.0264***	−0.00470
	(0.0122)	(0.00876)	(0.00632)	(0.00392)
Unregistered business	−0.0310	−0.0352	−0.299***	−0.00872
	(0.0369)	(0.0236)	(0.0289)	(0.0102)
Share of indigenous population	−0.0923+	−0.0162	0.0176	−0.00223
	(0.0486)	(0.0241)	(0.0224)	(0.0165)
Population density	−0.0000006	−0.000000989	−8.73e-08	0.000000134
	(0.00000102)	(0.000000799)	(0.000000549)	(0.000000494)
Year survey was administered = 2020	−0.0528***	−0.0162***	−0.0211***	0.000612
	(0.00754)	(0.00218)	(0.00575)	(0.00333)
Observations	12,708	12,708	12,708	12,708

Notes: Standard errors in parentheses; + p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001. Regional controls included but not reported.

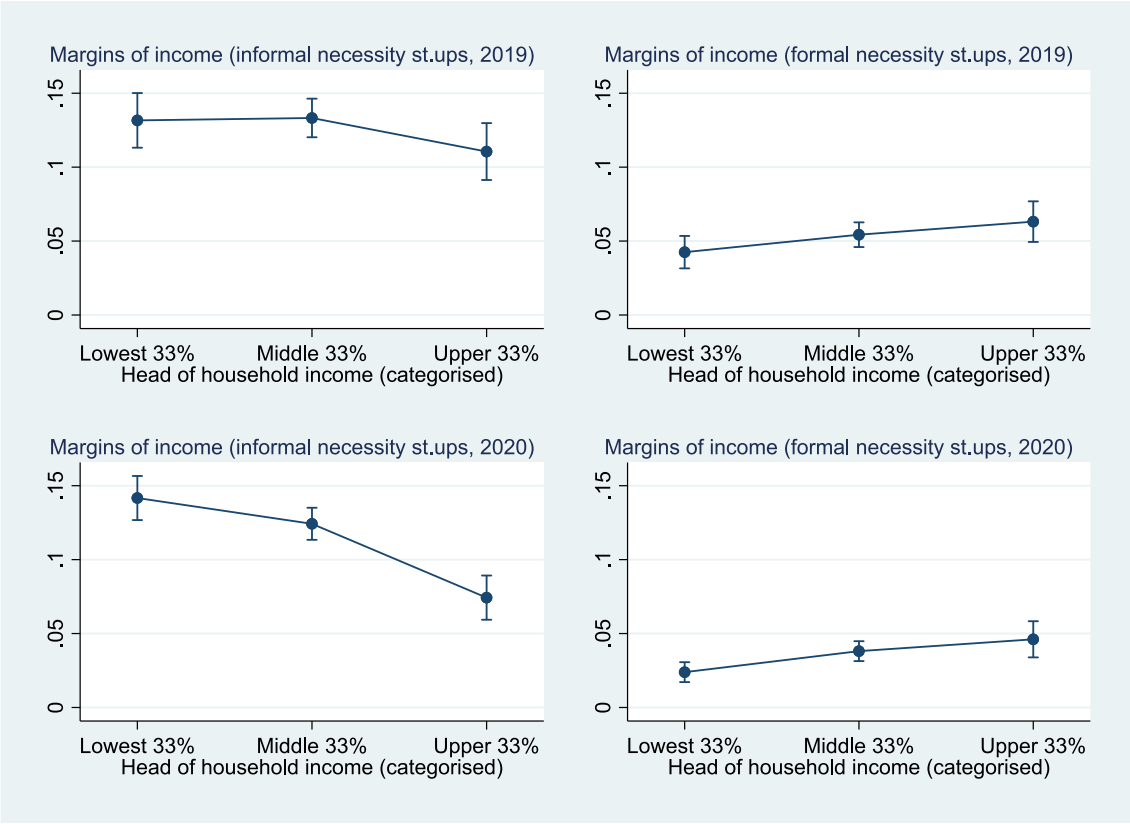

Fig. 4. Marginal effects of income, formal-informal entry, and necessity, 2019 and 2020.

becomes institutionally embedded. This expectation is in line with the literature that emphasises that cultural and social changes are likely to follow crises (Warnecke, 2013). Future research should consider cross-country studies that allow a better understanding of how the quantity and quality of entrepreneurship, including the growth aspirations, have been impacted by the COVID-19 government policies implemented around the world. Parallel to this, the COVID-19 crisis may induce some shifts in technology and methods of doing business, including greater use of the Internet. This may have implications for the trade-offs between formal and informal entry, including the reduction of the gender gap (Guerrero and Yañez-Valdes, 2023).

Further, although we intentionally restricted ourselves to the economic perspective, there may be an impact of informal institutions (culture) through the observed effect of indigenous groups that sustained unregistered ventures during the crisis. As in many other

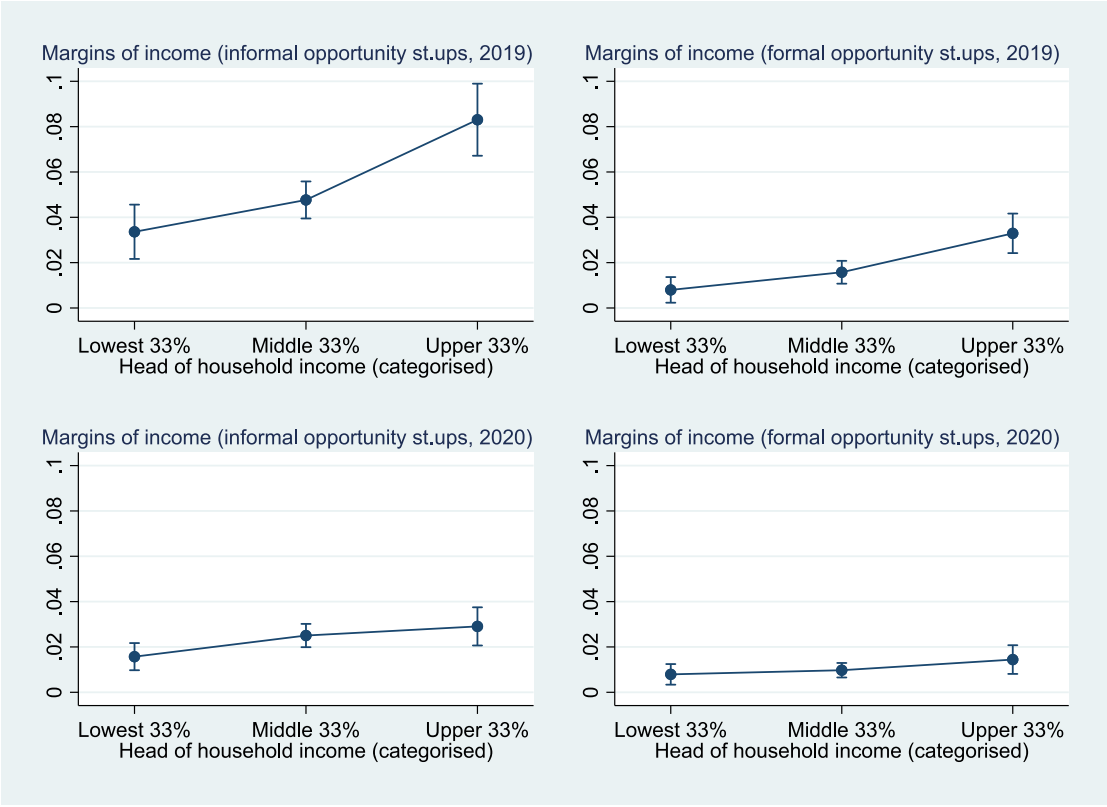

Fig. 5. Marginal effects of income, formal-informal entry, and opportunity, 2019 and 2020.

countries of the Americas (Anderson et al., 2006), indigenous communities in Chile have a history of state oppression, including in recent times (Jaimovich and Toledo, 2021). It is a policy challenge to build trust and integrate these communities better with the formal sector, and, therefore, to open wider entrepreneurial opportunities. In this regard, we need more contributions to the academic debate on the distinctiveness of local indigenous groups (Bruton et al., 2022); our four-way categorisation of entrepreneurial entry behaviours may help in this analysis.

Our study is of a preliminary nature, and we left several other themes unexplored. Bustamante et al. (2020) focus on social attitudes that support entrepreneurship and find that crises are associated with a positive shift in such attitudes. This could explain some additional variation in our outcome variables, as these positive entrepreneurial attitudes work directly through individual motivation, and indirectly through easier access to resources supported by the social environment. This channel is worth exploring further. Likewise, we do not isolate the social objectives that may be embedded in many entrepreneurial projects started during the pandemic. Pless (2012) and Santos et al. (2017) argue that crises lead to the reactivation of social norms of mutual support and that this, in turn, explains the emergence of social entrepreneurship during and after crisis. Again, this is worth exploring further.

6.3. Implications for practitioners

Our fine-grained distinction between the formal-informal and opportunity-necessity contrasts in entrepreneurship may have implications for entrepreneurs, policymakers, and support organisations. Understanding these concepts jointly may help with the tailoring of strategies and interventions that address the unique challenges and opportunities of emerging and developing economies.

Our results highlight the importance of income as a determinant of the type of entrepreneurial entry that individuals undertake. Learning more about how prior income is related to different types of entrepreneurial entry is important not just for researchers but also for entrepreneurs themselves, because it helps them understand the entrepreneurial landscape they face. This understanding can also help policymakers to calibrate policies that support entrepreneurship, tailor educational programs for different income groups, and design strategies that promote a diverse and resilient entrepreneurial ecosystem that fully accounts for the wide socio-economic spectrum.

Policymakers should recognise the prevalence and importance of informal entrepreneurship, not only as an occupation of last resort but also as a potential space for testing new entrepreneurial opportunities which, if successful, are likely to be transformed into formal firms. To shift the balance towards formal entrepreneurship, entrepreneurship policies should focus on access to resources (skills as well as finance) by lower-income individuals. In emerging economies like Chile, it is crucial to promote alternative funding sources for lower-income individuals, including marginalised groups like immigrants, through legitimising and incentivising business angel

networks, crowdfunding platforms, and others. University managers and ecosystem agents should improve existing entrepreneurship training, and target informal-necessity entrepreneurs to enhance the skills, abilities, and capabilities that are needed to start a successful business with limited resources. While informal-necessity entrepreneurs may benefit from low-tech, inexpensive, practical solutions, a digital or a differentiation strategy that accounts for regional capabilities may be applied to enhance successful opportunity entrepreneurship that will likely end up in the formal sector. Here, access to technology and infrastructure may prove critical (Guerrero et al., 2024). Knowledge transfers from formal-opportunity entrepreneurs to informal-necessity entrepreneurs should be supported, and grass-root community organisations may play a role here. Last, but not least, decreasing the administrative set-up cost of formal businesses continues to be important (Djankov et al., 2002).

CRediT authorship contribution statement

Saul Estrin: Writing – review & editing, Writing – original draft, Validation, Methodology, Formal analysis, Data curation, Conceptualization. **Maribel Guerrero:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Tomasz Mickiewicz:** Writing – review & editing, Writing – original draft, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Data availability

Data will be made available on request.

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